AGRICULTURAL ENGINEERING

JULY • 1955

In this Issue . . .

Power Distribution and Requirements of a Flail-Type Forage Harvester

•

Engineers Develop Special Equipment for Mechanical Feeding of Livestock

•

Engineering Study Reveals the Effect of Non-Linear Air Flow in Grain Drying

•

Combating Sediment Production in Small Watersheds Presents Engineering Challenge

•

Some Research Results of Pasture Irrigation in Combination with Nitrogen Applications

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

. . . for TWO yields in ONCE over the field

New CASE Corn Harvester

- **Picks and Husks Ears**
- **Chops or Shreds Stalks**
- **Lowers Ration Costs**
- **Helps Control Borers**
- **Saves Shelled Corn**
- **Cuts Costs and Work in Seedbed Preparation**

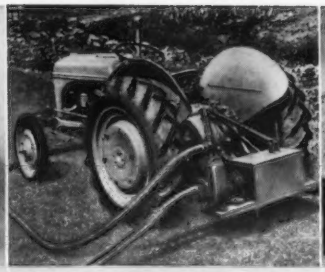
Harvesting two crops in one operation . . . at the same time and with the same power . . . seems almost unbelievable. Yet, it's true. The new Case Corn Harvester is just such a machine —so unique in design it picks and loads ears in one wagon while chopping and blowing stalks into another—so amazingly practical that any farmer or livestock feeder can adopt the new low-cost method of feeding corn stalk silage to lower his ration costs by as much as half. For those who prefer, the chopped stalks may be fed as dry stover or even used as the best of absorbent bedding. Also phenomenal is the Case Corn Harvester's surprising feature which saves the shelled kernels ordinarily lost in mechanical picking—and it's this bushels-per-acre salvage that pays for the unit in a few hundred acres. To provide even greater savings the same base machine with other units—windrow pick-up, cutter-bar or row-crop . . . harvests all forage crops for hay, silage and daily green feeding.

Send for free Pamphlet on "Making Cheaper Beef"

If you're interested in the practice of feeding low-cost corn stalk silage and how it fits into ration requirements, just send for the booklet entitled "Making Cheaper Beef." Ask also for the Case Corn Harvester catalog which illustrates and tells how this amazing machine works . . . why it helps farmers in so many ways, including the control of corn borers, speeding the decay of tough stalks and making plowing, disking, harrowing and cultivating of the next crop on the same field so much easier. For other educational and training aids, request the pamphlet "Visual Aids to Modern Farming." J. I. Case Co., Racine, Wis.

ROTARY CULTIVATOR
Cultro, Inc.

TRANSPORT MIXER WAGON
Chase Foundry & Manufacturing Co.



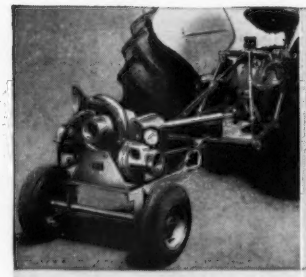
TRAC-MOUNT PUMPER
Roper Manufacturing Co.

HOPTO DIGGER
Badger Machine Co.

Specialized Implements sell better

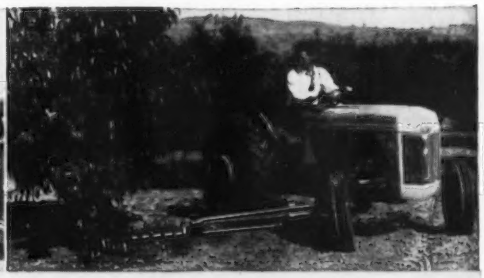
with well-known, well-proved

BLOOD BROTHERS P.T.O. Drive Lines



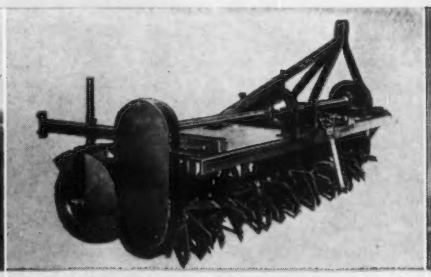
TRAILER PUMPER
The Gorman-Rupp Co.

CROPGUARD FARM DRYER
Lakeshore Manufacturing Co.

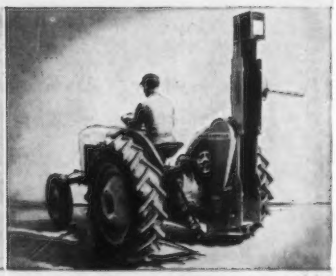


TREE TILLER
Trump Ltd.

P.T.O. FERTILIZER SPREADER
Century Engineering Corp.



P.T.O. ROTARY CULTIVATOR
Victory Peanut Harvester Co.



MOUNTED POST DRIVER
Danuser Machine Co.

Now that well-developed implements have mechanized *major* farm tasks, farmers want more and more *specialized* machines to speed other chores.

To assure success for *your* new, specialized implements, make sure they're designed for p.t.o. drive—and equipped with Blood Brothers Jointed Drive Lines.

Farmers know them . . . like them . . . and their unsurpassed dependability helps any implement *sell better!*

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS • JULY, 1955 • Vol. 36, No. 7

Power Distribution and Requirements of a Flail-Type Forage Harvester 453
C. W. Bockhop and Kenneth K. Barnes

Mechanical Feeding of Livestock 458
John B. Dobie

Non-Linear Air Flow in Grain Drying 462
W. V. Hukill and C. K. Shedd

Sediment Production in Small Watersheds 467
Russell Woodburn

Irrigation of Pastures 471
Gilbert Levine, W. K. Kennedy and H. E Gray

The 1955 ASAE Gold Medalists 474

The President's Annual Address 477
George B. Nutt

News Section 480

Index to Advertisers 496

Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm form, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 N. First St., Ann Arbor, Michigan.

OFFICERS AND COUNCIL
American Society of Agricultural Engineers

Wayne H. Worthington, President

VICE-PRESIDENTS
Henry J. Barre
Harold H. Beaty
James W. Martin

COUNCILORS
George M. Eveleth
Richard K. Frevert
Harry W. Dearing, Jr.

PAST-PRESIDENTS
George B. Nutt
Edwin W. Tanquary

CENTRAL OFFICE STAFF
St. Joseph, Michigan

Frank B. Lanham, Secretary
Raymond Olney, Treasurer
Ralph A. Palmer, Assistant Secretary
Mrs. Hazel B. Smiley, Office Manager

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

RAYMOND OLNEY
Editor and Publisher

JAMES BASSELMAN
Associate Editor

ADVERTISING REPRESENTATIVES

Chicago 2:
DWIGHT EARLY & SONS
100 North LaSalle St.
Tel. CEntral 6-2184

New York 17:
BILLINGSLEA & FICKE
420 Lexington Ave.
Tel. LExington 2-3667

Los Angeles 43:
JUSTIN HANNON
4710 Crenshaw Blvd.
Tel. AXminster 2-9501

SUBSCRIPTION PRICE: $4.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 40 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

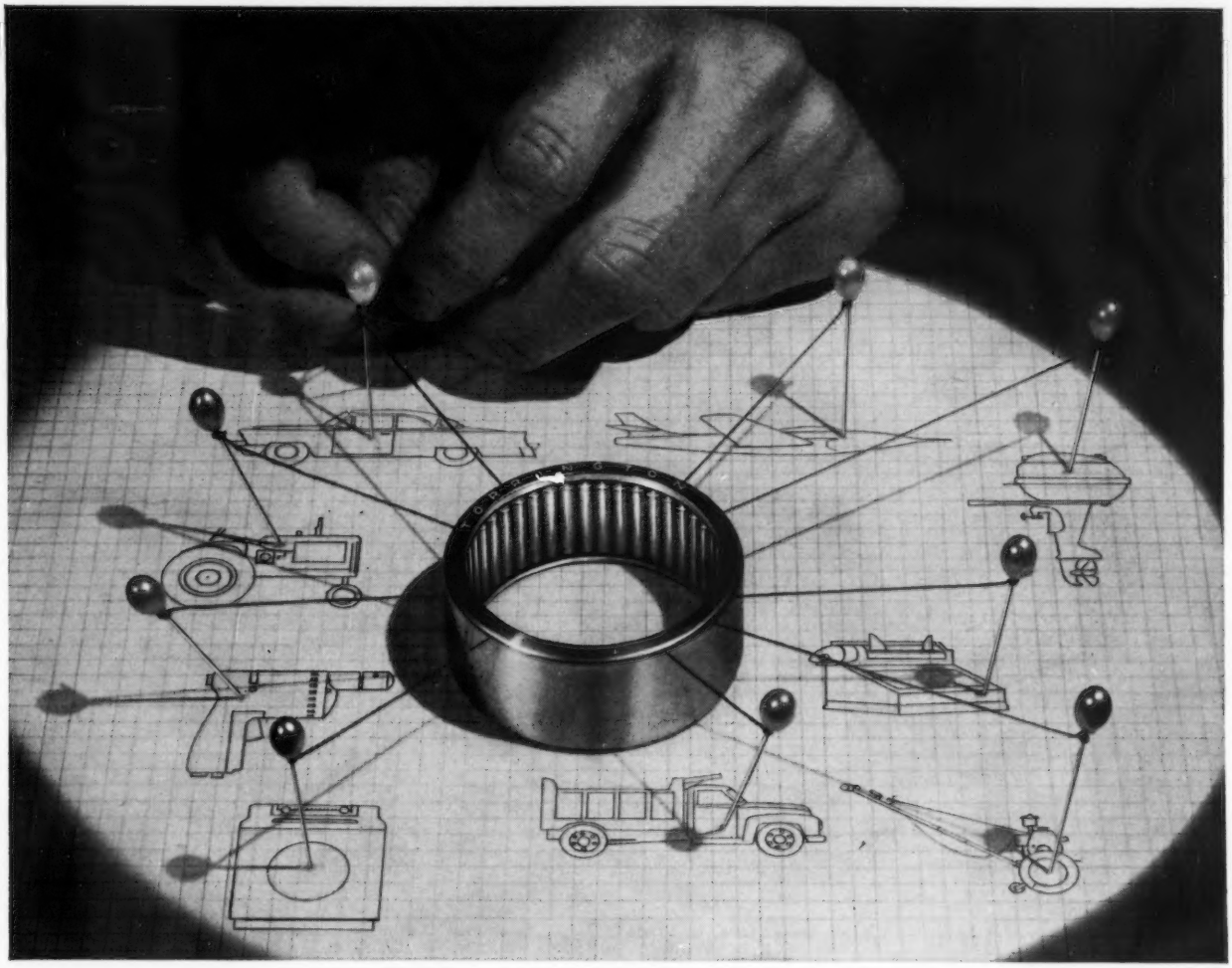
The American Society of Agricultural Engineers is not responsible for statements and opinions advanced in its meetings or printed in its publications; they represent the views of the individuals to whom they are credited and are not binding on the society as a whole.

TITLE: The title AGRICULTURAL ENGINEERING is registered in the United States Patent Office.

COPYRIGHT: Copyright, 1955, by the American Society of Agricultural Engineers.

Reprints may be made from this publication on condition that full credit be given AGRICULTURAL ENGINEERING and the author, and that date of publication be stated.

AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.



"The **TORRINGTON Needle Bearing** *is Versatile"*

It can whip friction in one of our newest jet fighters at terrific altitudes and speeds. It can pitch in and help a Kansas farmer cut his wheat. Or it can help your wife park the family car in a tight spot without a struggle.

Wherever the Torrington Needle Bearing is put to work, its unique combination of high radial load capacity and small size enables designers and manufacturers to make their products stronger, lighter and more compact. That's why this versatile bearing has become "standard equipment" in thousands of products throughout industry.

In the twenty years that the Needle Bearing has been made, Torrington's Engineering Department has accumulated many lifetimes of experience in adapting the bearing's advantages to products as diverse in size and use as adding machines and tractors. We are always glad to make this experience available to you. *It can be obtained nowhere else.*

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for a catalog.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

These features make the **TORRINGTON NEEDLE BEARING** *unique*

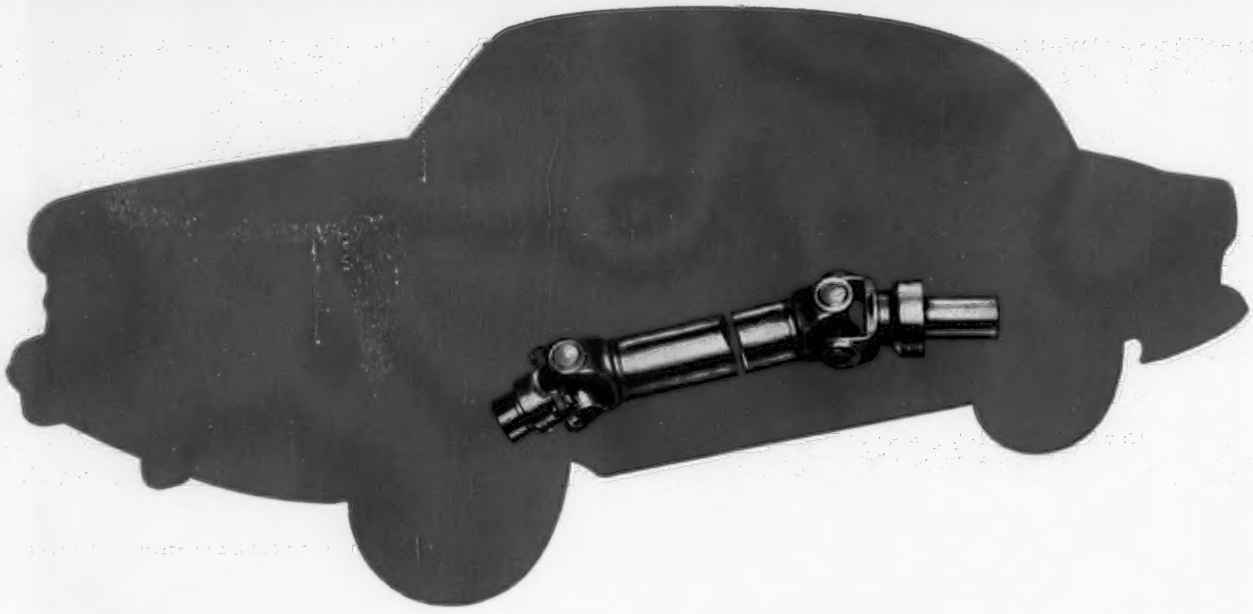
- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits larger and stiffer shafts

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* **BEARINGS**

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

COMPETENT

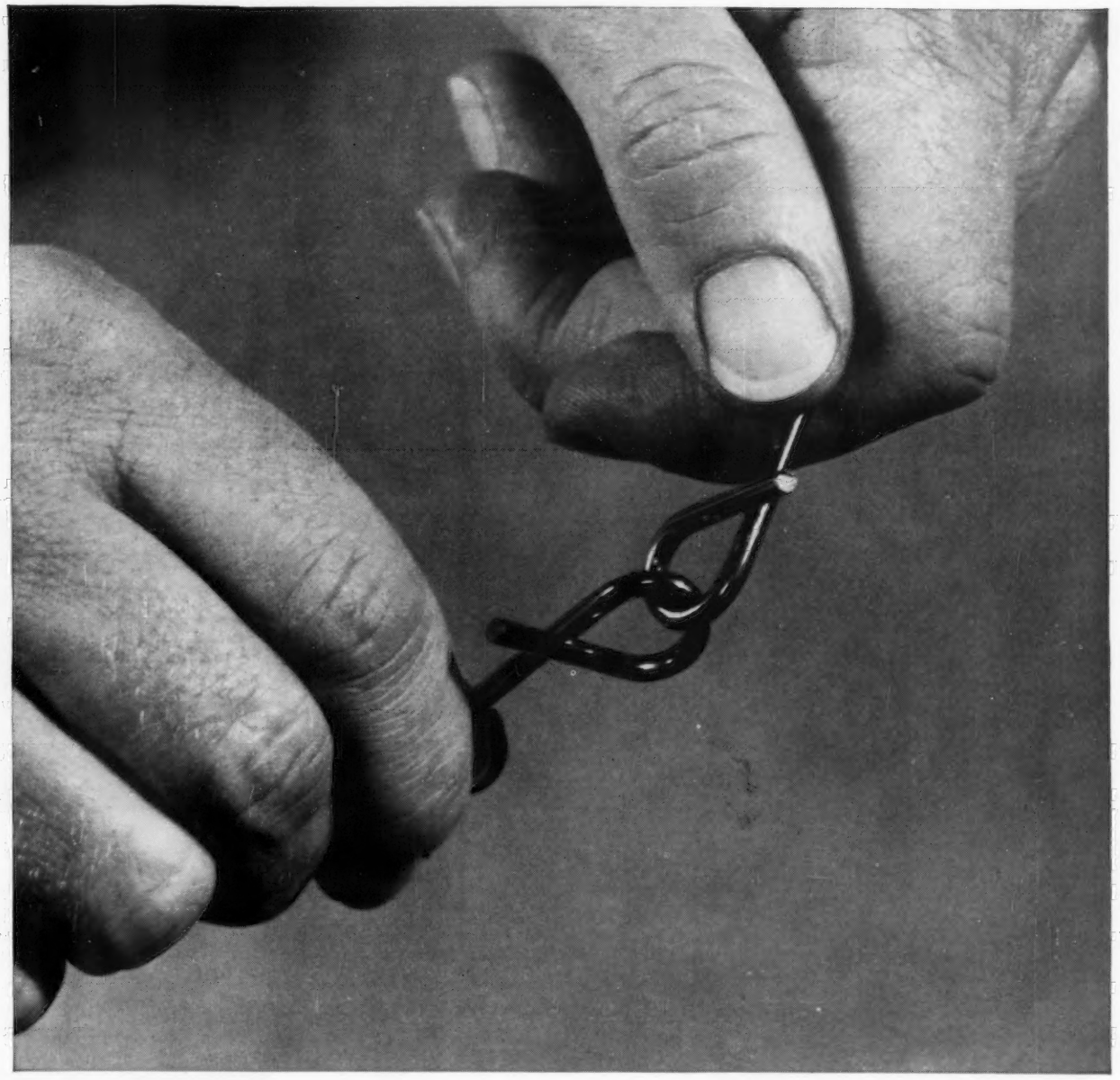


For the very latest in design and highest quality workmanship — America's leading automobiles, from the smallest to the largest, rely on MECHANICS. MECHANICS drive lines are engineered to meet each customer's specific needs. Torque, size, weight, balance, angularity, runout, safety, lubrication, assembly and service problems all have been overcome — to each customer's complete satisfaction. Let us help engineer joints and drive lines to fit Your products.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2046 Harrison Ave., Rockford, Ill.

MECHANICS
Roller Bearing B-W
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment



Can You Find the Solution to a Chain Problem?

If you need help to find the answer to the chain problems of equipment design, the complete CHAIN Belt Line of agricultural implement chains has your economical answer.

Because CHAIN Belt has always stayed abreast... even ahead of your needs... you can find the answer you want in this complete line. And, CHAIN Belt engineers are constantly studying chain application problems of agricultural implements. Many new developments have been completed... more are under way.

Why not be sure you have the up-to-date solutions for your chain problems? Consult your CHAIN Belt District Sales Engineer or write CHAIN Belt Company, 4680 W. Greenfield Ave., Milwaukee 1, Wis., for your copy of Agricultural Chain Catalog No. 54-54.

CHAIN BELT COMPANY

District Sales Offices in all principal cities

AUTO-LITE TRANSPORT SPARK PLUGS

Farmers get top performance from their trucks, tractors and heavy-duty equipment with this new plug because:

EXTRA-BIG ELECTRODES—give extra miles of long, dependable service without constant regapping and cleaning.

RUGGED CONSTRUCTION—helps withstand the heavy shocks and abuses from the most severe farm operation.

AIRCRAFT TYPE INSULATION—the finest material ever developed—resists high temperatures—plugs stay clean even under idling or other "cold engine" conditions.

WIDEST HEAT RANGE—assures peak efficiency through widest range of operating conditions from heavy pull to light idling.

Original factory equipment on many leading makes of trucks and tractors. Remember, Auto-Lite is a complete spark plug line, with standard, transport and resistor types for all service conditions.

ORIGINAL

AUTO-LITE "STA-FUL" BATTERY FOR TRACTORS

Now available! A newly designed "Sta-ful" Battery especially built for tractors, light trucks and other off-the-road machinery. Auto-Lite "Sta-ful" needs water only ⅓ as often in normal tractor use. New rugged case withstands heavy shocks . . . Fibre-glass insulation gives longer life . . . extra liquid reserve protects battery plates to save customers time and worry. Auto-Lite is a complete battery line—specified as original equipment for many leading makes of cars, trucks, and tractors.

AUTO-LITE WIRE AND CABLE

Auto-Lite is a complete line—featuring sensational new Neosheath Spark Plug Wire Sets that keep plugs dry, famous Flextrand Primary Wire that is easier to install, Auto-Lite Battery Cable with the new anti-corrode Power-Line Terminal. Auto-Lite Cable Products are original factory equipment on leading makes of tractors, trucks and farm equipment.

AUTO-LITE ELECTRICAL SYSTEMS

Coils, distributors, generators, starting motors, voltage regulators, and all other important parts of the electrical system are engineered by Auto-Lite to fit together and work together as a perfect team. Quality tested for unfailing dependability. Original factory equipment on many makes of cars, trucks and tractors.

ONE OR MORE AUTO-LITE ELECTRICAL UNITS ARE USED ON FARM EQUIPMENT MANUFACTURED BY

Allis-Chalmers
Earthmaster
Centaur
International Harvester
Massey-Harris

EQUIPMENT The Key to bigger profits for Farm Equipment Dealers

SELL the brand that farmers know . . . sell Auto-Lite. Millions of Auto-Lite original factory-equipped cars, trucks and tractors are impressive proof of the quality and dependability of Auto-Lite electrical equipment. Today, Auto-Lite is the world's largest independent manufacturer of automotive electrical equipment. Look at the famous names of farm equipment manufacturers at the right who use one or more Auto-Lite products . . . and you'll know why "You're always right with Auto-Lite."

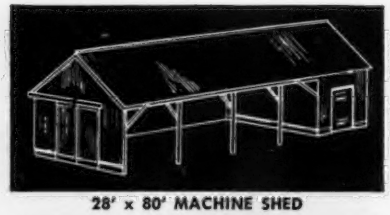
American Terratrac
John Deere
Gleaner
Food Machinery Corporation
Harris
Willys
Cockshutt
Long
Fate Root Heath
Sheppard
Custom
Oliver
J. I. Case
Intercontinental
Love
Minneapolis-Moline
Ferguson

THE ELECTRIC AUTO-LITE COMPANY
Toledo 1, Ohio Toronto, Ontario

AUTO-LITE

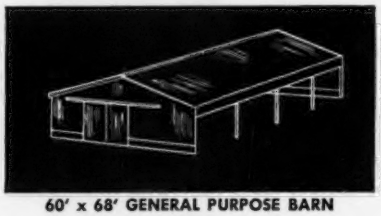
THE ORIGINAL EQUIPMENT LINE

FREE County Agent Kit . . . to Vo-Ag teachers and County Agents!



28′ x 80′ MACHINE SHED

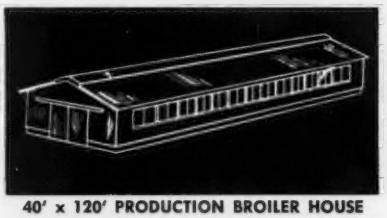
40′ x 80′ STABLE BARN



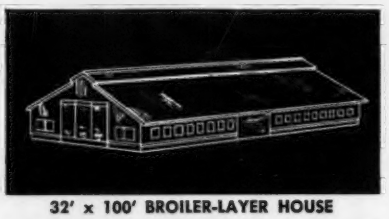
60′ x 68′ GENERAL PURPOSE BARN

26′ x 45′ MULTI-PURPOSE STORAGE SHED

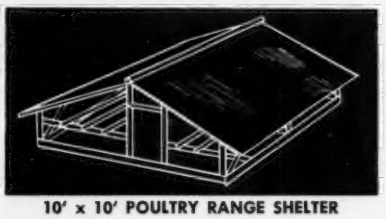
Includes sample farm building plan for low-cost construction



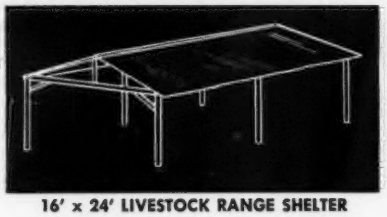
40′ x 120′ PRODUCTION BROILER HOUSE



32′ x 100′ BROILER-LAYER HOUSE

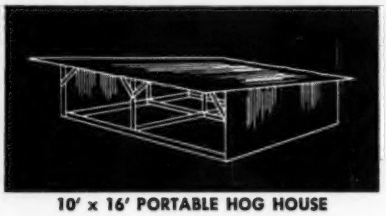


10′ x 10′ POULTRY RANGE SHELTER



16′ x 24′ LIVESTOCK RANGE SHELTER

18′ x 40′ MILKING BARN



10′ x 16′ PORTABLE HOG HOUSE

KAISER ALUMINUM is offering you a free County Agent Kit—including a new booklet entitled "Farm Guide," estimating and application instructions for aluminum roofing, a catalog with price list on Kaiser Aluminum farm building plans—*plus a sample plan.* You can use this information to help farmers improve their construction techniques.

In developing the ten plans (shown above) for Kaiser Aluminum, agricultural engineering specialists improved on conventional designs for farm buildings to make them *more functional, easier to build, more durable* and *economical.*

Most of the plans feature low-cost pole type construction. Each is a *complete set of blueprints*—including section details, elevations, erection instructions, bill of materials!

With your help these plans will enable farmers to profitably apply the many advantages of Kaiser Aluminum Roofing. Available in 26″-wide sheets, or in the new, 48″-wide size that saves 7% to 11% in metal, and greatly speeds installation time.

Among Kaiser Aluminum's many advantages are: light weight with strength, reflection of hot summer sun, retention of winter warmth, long life with no red rust streaks, no rotting, no warping. And Kaiser Aluminum Roofing is economical because it requires less maintenance, is easily applied, never needs paint. Permanently attractive. It's the performance tested aluminum roofing material.

Kaiser Aluminum & Chemical Sales, Inc.
Farm Building Plan Service
6755 Kaiser Building, Oakland 12, California

Please send a free County Agent Kit to:

NAME _____

ORGANIZATION _____

ADDRESS _____

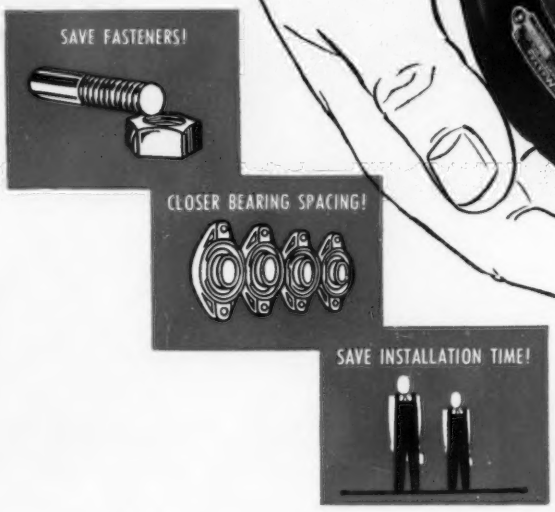
CITY AND STATE _____

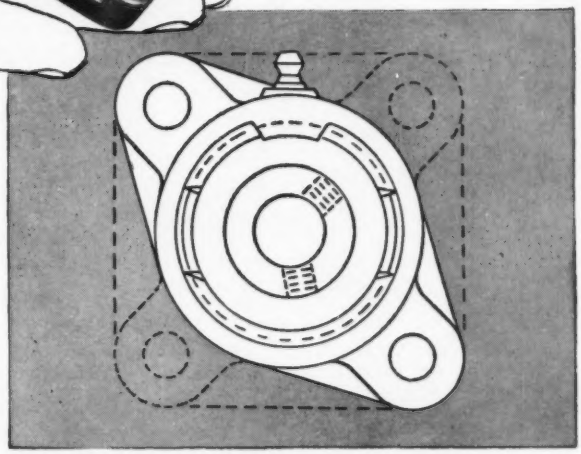
Kaiser Aluminum

The Quality Roofing for Better Farm Buildings

Attach this coupon to your letterhead and mail today!
A County Agent Kit will be sent without obligation to Vo-Ag teachers, Extension Specialists and County Agents.

NOW! SEALMASTER cuts corners to save DOLLARS for you!





Check these facts!

- Cuts installation costs by eliminating two fasteners and punching or drilling operation required for two mounting holes.
- Permits closer bearing spacing on multiple shaft installations.
- As a replacement bearing unit fits the diagonal bolt centers on present four-bolt flange units.
- Carries the same load rating for a given shaft size as four bolt units.
- Retains all patented design features of SEALMASTER Bearing Units—Zone Hardening, Self-Alignment, Locking Pin & Perimeter Dimple and Labyrinth Seal.
- Available in shaft sizes from ½ to 2 3/16 inches.

New SEALMASTER 2-BOLT FLANGE UNIT

Call your SEALMASTER Distributor or mail this coupon today!

Please send Bulletin SS-125 containing full information on the new SEALMASTER 2-Bolt Flange Ball Bearing Unit.

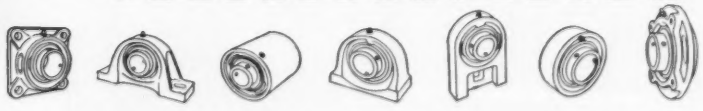
NAME_____

FIRM_____

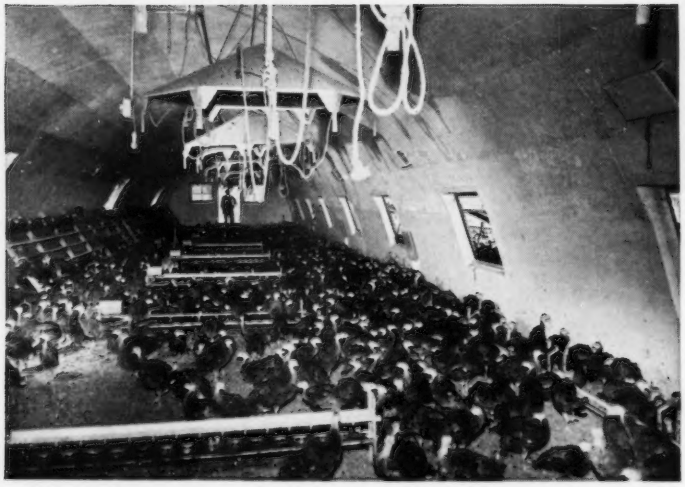
ADDRESS_____

CITY_____ STATE_____

SEALMASTER BALL BEARING UNITS

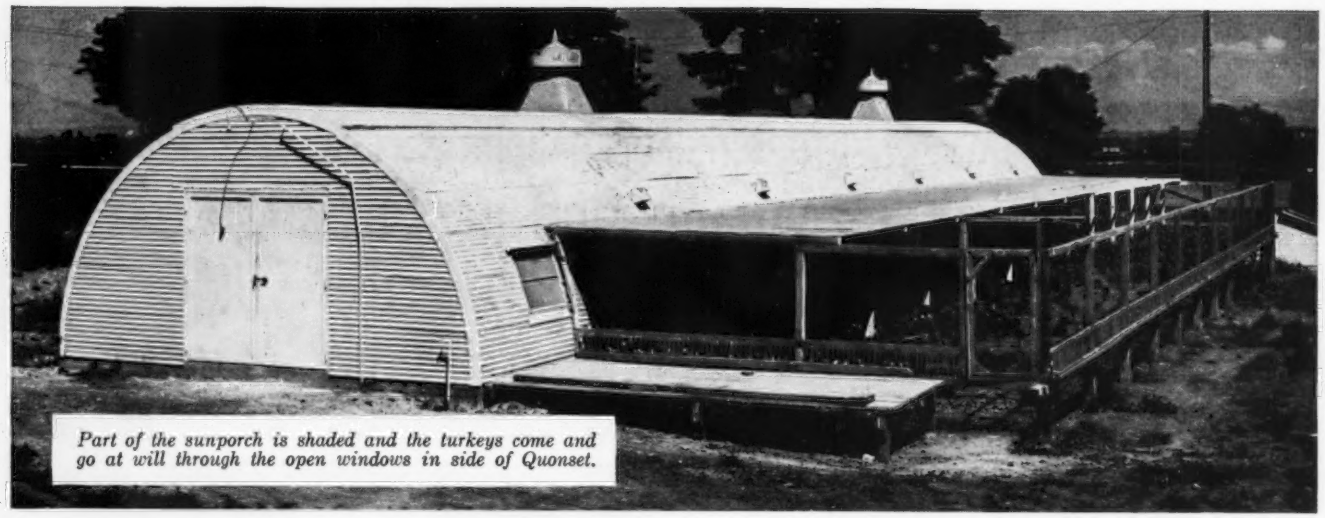


SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. • 69 RIDGEWAY AVE., AURORA, ILLINOIS



Some turkeys like to eat inside, some outside. To make sure they all get enough, Mr. and Mrs. James Rusk have put troughs on the welded steel sunporch outside brooder house. Flowing water is available to turkeys through lattice at the edge of sunporch floor.

Taking care of 3,500 turkeys in this Quonset brooder house is easy. Automatic watering and feeding hold labor to a minimum. Gas brooders are used and no extra heat is needed in the well-insulated Quonset. Rusk plans to build two more Quonset brooder houses later this year.



Part of the sunporch is shaded and the turkeys come and go at will through the open windows in side of Quonset.

Turkeys from Horse Heaven

At the foot of the Horse Heaven Hills, in the shadow of snow-capped Mount Adams, Mr. and Mrs. James Rusk have combined dry lands and the fertile irrigated soils of the Yakima Valley of Washington to develop a turkey operation based on thorough disease control and increased labor efficiency.

The James Rusk farm at Mabton, Wash., consists of 240 acres—100 acres of dry land used for turkey range, and the balance irrigated. The irrigated lands are planted to mint for mint oil production, alfalfa hay, corn for feed, and wheat. The dry range acreage is separated into 36 pens, 18 of which are used each year.

To fully utilize his labor force, Jim plants crops that will free men for the turkey operations when extra help is needed in this major enterprise. A regular force of two men care for the turkeys in the brooder houses, and two other men care for the birds on the range.

The farm has been planned for all mechanization possible. For example, range feed is bought in bulk, stored in the large granary in bulk, and fed from a bulk feeder truck by auger spouts into the range feeders.

The old-style brooder houses have outdoor feeders, used as soon as the birds are big enough to find the feed on the sunporches. This operation was greatly improved last year when a new Quonset brooder house was built and 3,500 birds at a time were reared in the new Quonset.

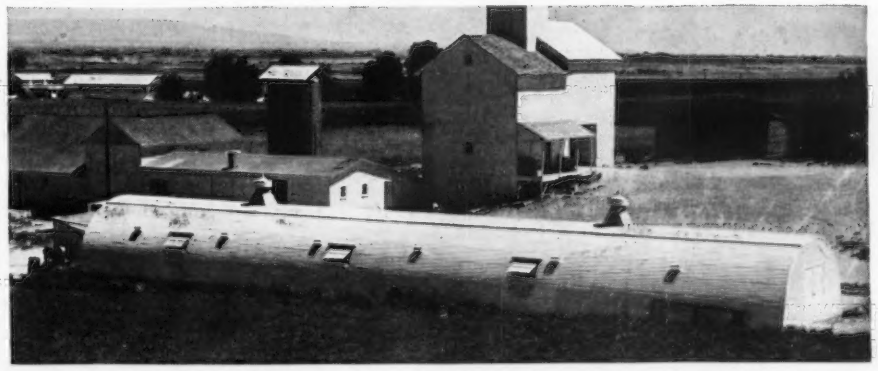
With automatic feeders and fountains in the new Quonset, the 3,500 birds are cared for in one-half man-hours daily. The old system of small individual brooder houses for 1,000 birds took one man-hour per 1,000 birds.

This improvement alone saved over $1,500 a year in labor plus the advantages of the longer life of the building and lower repair costs.

Jim Rusk also reports that the even temperature inside the Quonset brooder house has paid big dividends over the "hot and cold" old-style buildings used previously. Cleaning time is reduced and Jim said, "I like the looks of that substantial building after seeing those old shacks for so long."

There's a Quonset® for Every Job on your Farmstead

Stran-Steel Division
GREAT LAKES STEEL CORPORATION
Ecorse, Detroit 29, Mich. • A Unit of
NATIONAL STEEL CORPORATION



At the foot of the Horse Heaven Hills, where Indian ponies used to run free in belly-deep grass, is Jim Rusk's farm. Grain storage is located in the rear, machinery storage and shops at left.

792 million gallons of water in 11,000 hours at a fuel cost of $4.74 per million gallons . . .

that's Chrysler V-8 economy and performance

Tom Bostic of Plainview, Texas watches the performance of his Chrysler V-8 powered Green Irrigation Pump. This is the first Chrysler V-8 powered irrigation pump installed by Green Machinery Company. It was placed in service on Bostic's 320-acre farm in April 1951. Now into its fourth year, the original pump and Chrysler Industrial V-8 331 cubic inches displacement engine have delivered an average of 1200 GPM for 11,000 hours for a grand total of 792 MILLION gallons of water. In irrigating his cotton, wheat and grain sorghum, Bostic burns butane fuel, his Chrysler Engine using 5¼ gallons of butane per hour. Priced at 6½¢ a gallon, it has cost him $3,753.75 to produce this amazing volume of water. In that time he has irrigated four crops each of cotton and grain sorghum and eight crops of wheat.

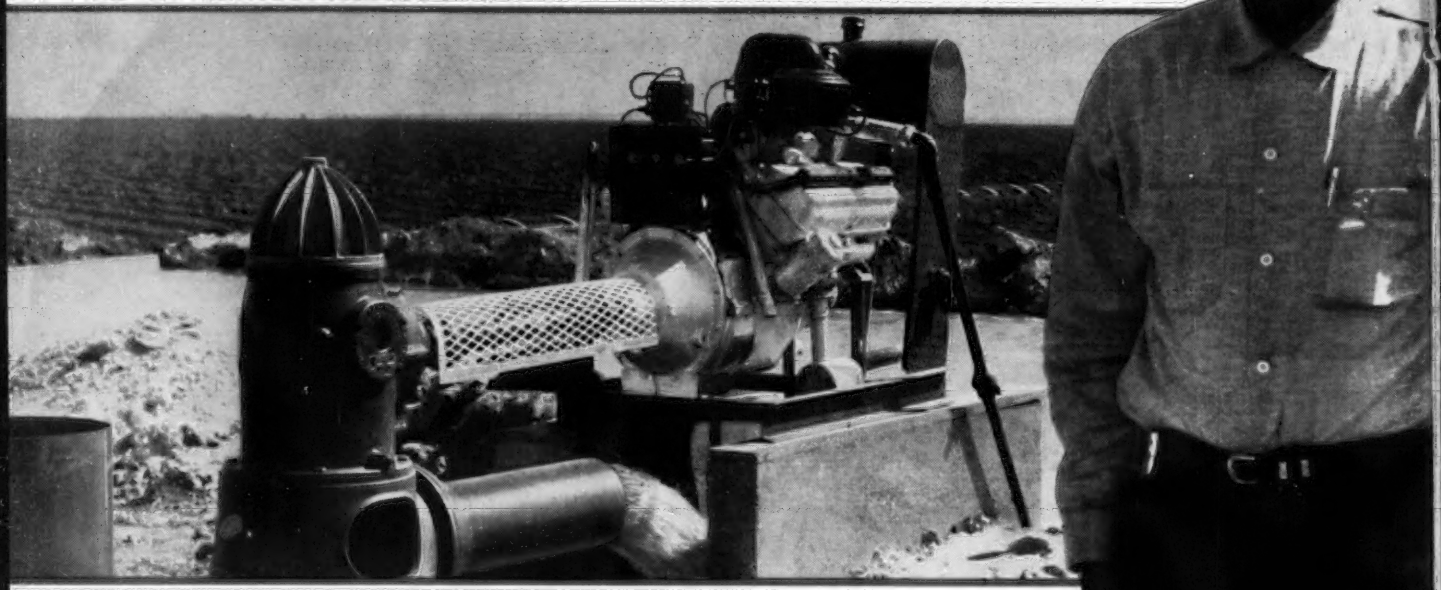


PHOTO COURTESY GREEN MACHINERY COMPANY, PLAINVIEW, TEXAS

How's that for a sample of Chrysler performance *plus* economy? With a comparable diesel-powered engine at the present cost of diesel fuel (14½¢ a gallon), it would have cost this grower *more than twice as much to produce that much water.*

Then, if you compare first costs, you find a Chrysler Industrial V-8 Engine costs less than one-half the cost of comparable diesel power.

Chrysler Ind. 24A
331 cubic inches
Displacement Engine

Leading deep well turbine pump manufacturers, like Green Machinery Company, offer Chrysler Industrial V-8 Engines as standard power in their units. They know they can depend upon Chrysler Industrial Engines to deliver the kind of power that breaks records every day.

Regardless of the fuel of your choice, gasoline, butane or natural gas, you can expect the best from Chrysler . . . best economy . . . best performance . . . best dependability. Ask a Chrysler Industrial Engine Dealer for details on Chrysler Industrial Engines, 230 to 413 cubic inches displacement, or write for catalogue: ***Dept. 177, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

CHRYSLER
Industrial Engines

INDUSTRIAL
ENGINE DIVISION
CHRYSLER
CORPORATION

HORSEPOWER WITH A PEDIGREE

For Leading Makes of Farm Machinery

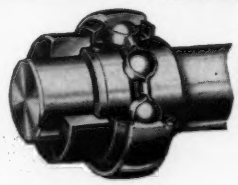
ALLIS-CHALMERS • J. I. CASE
JOHN DEERE • OLIVER
INTERNATIONAL HARVESTER
MASSEY-HARRIS-FERGUSON
MINNEAPOLIS-MOLINE • NEW IDEA

FAFNIR WIRELOC BEARING that simplifies designing by eliminating the need for housing shoulders.

FAFNIR LOW-COST PRESSED STEEL LINE of ball bearing power transmission units. Flangette illustrated.

...turning points to improved performance

More opportunities to make use of anti-friction bearings accounts in no small measure for the popularity of FAFNIR with leading manufacturers of farm tractors and equipment. Through important developments in ball bearings such as the wide inner ring bearing with self-locking collar, the Wireloc radial bearing, the Flangette, these manufacturers have found economical and efficient "turning points to improved performance" for their equipment. What's more, they have become better acquainted with other FAFNIR FEATURES including ... (1) the wide range of ball bearing types and sizes in the FAFNIR line, (2) the uniformly-high quality standards for every product, (3) the FAFNIR "attitude and aptitude" ... a way of looking at bearing problems from the designer's viewpoint, and the ability to come up with the right bearing for the job. Are *you* taking advantage of these benefits? The Fafnir Bearing Company, New Britain, Conn.



FAFNIR-ORIGINATED WIDE INNER RING BALL BEARING with Self-Locking Collar. Easiest of all to install.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

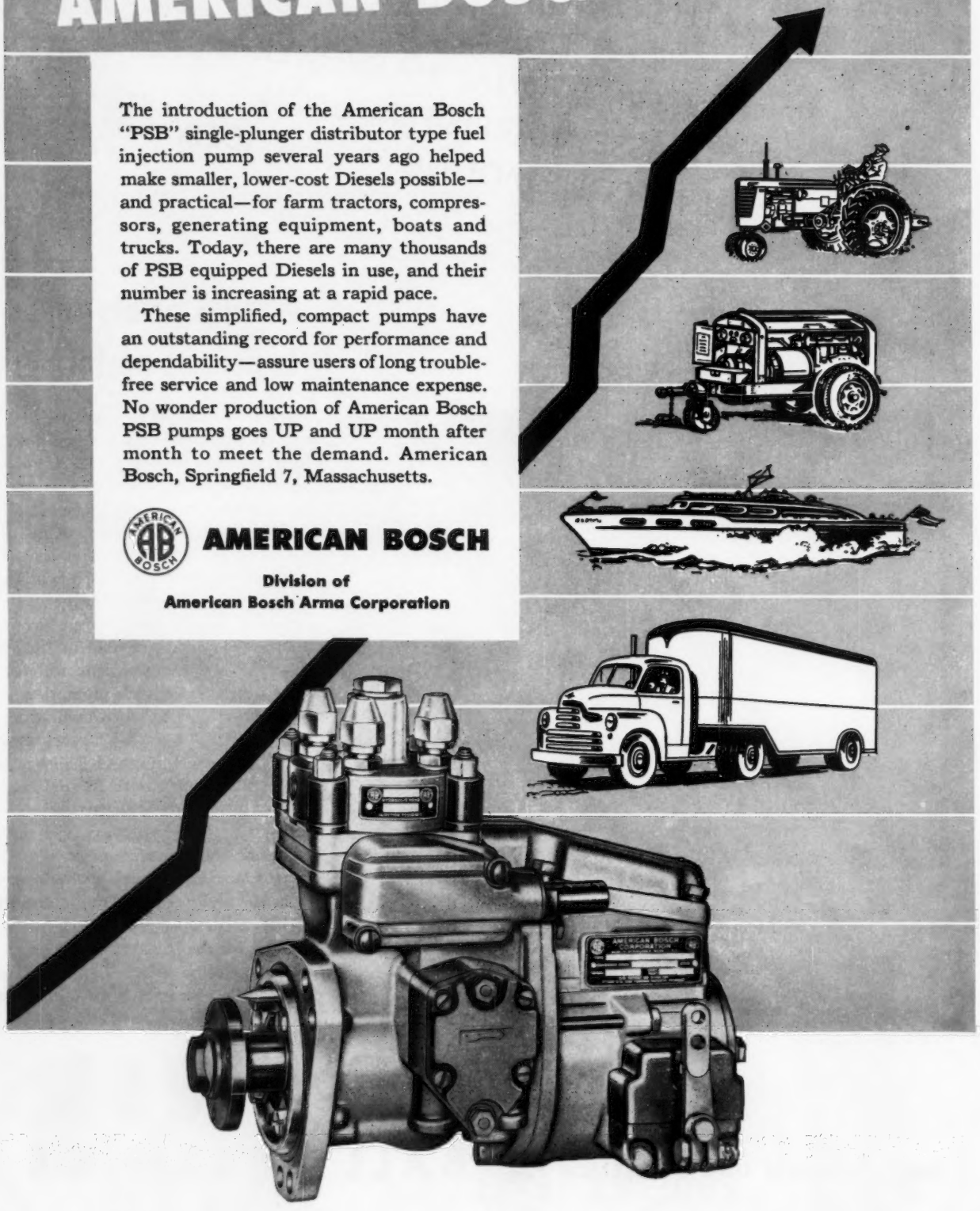
the UP and UP story on the AMERICAN BOSCH PSB!

The introduction of the American Bosch "PSB" single-plunger distributor type fuel injection pump several years ago helped make smaller, lower-cost Diesels possible—and practical—for farm tractors, compressors, generating equipment, boats and trucks. Today, there are many thousands of PSB equipped Diesels in use, and their number is increasing at a rapid pace.

These simplified, compact pumps have an outstanding record for performance and dependability—assure users of long trouble-free service and low maintenance expense. No wonder production of American Bosch PSB pumps goes UP and UP month after month to meet the demand. American Bosch, Springfield 7, Massachusetts.

AMERICAN BOSCH

Division of
American Bosch Arma Corporation



NEW!

ARMCO ALUMINUM-COATED STEEL

for outdoor service

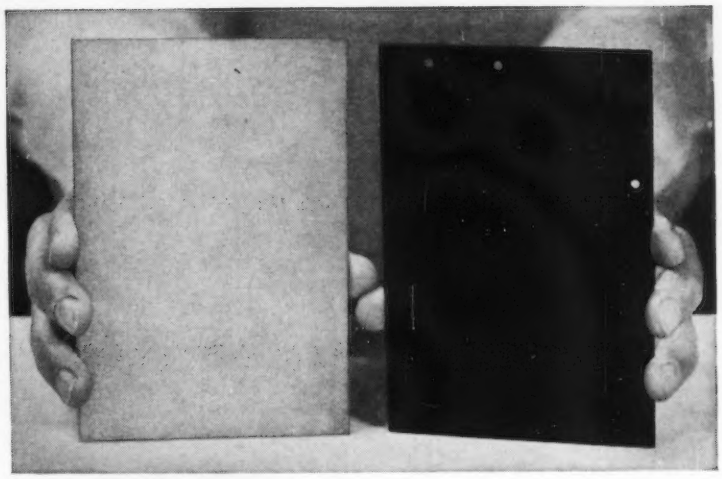
Combines Corrosion-Resisting Properties of Aluminum with Strength of Steel

A new hot-dip aluminum-coated sheet steel—known as Armco ALUMINIZED STEEL® (Type 2)—is now in production after 15 years of corrosion testing. It combines the surface advantages of aluminum with the strength of steel.

While zinc coatings have done a good job of protecting steel against rust, tests indicate this new aluminum-coated steel is greatly superior. The 15-year tests in an industrial area show the atmospheric corrosion resistance of this aluminum coating is at least 3 times that of a standard coating on galvanized steel sheets.

During the past year and a half of field development work, ALUMINIZED STEEL (Type 2) has been used in prefabricated industrial, commercial and farm buildings, industrial rolling doors, covers for silos and water storage tanks, roof deck, and other applications under general atmospheric conditions.

The new sheet is a companion grade to Armco ALUMINIZED STEEL (Type 1) exclusively produced by Armco since 1939 for high temperature service.



In atmosphere sufficiently corrosive to cause a standard galvanized coating (right) to fail completely in 12 years, Armco ALUMINIZED STEEL (Type 2), left, looked like this after 15 years. Cleaned samples show the aluminum coating is still giving full protection to the base metal.

QUESTIONS YOU MAY WANT ANSWERED

DOES IT "WEATHER" LIKE ALUMINUM?

Yes. The surface of samples of Armco ALUMINIZED STEEL (Type 2) and aluminum, exposed to the atmosphere for five years, cannot be told apart.

WHAT IS ITS STRENGTH?

Because it has a steel base it has the strength and rigidity of steel . . . thus avoiding problems common to weaker materials.

DOES IT REFLECT HEAT?

Yes, ALUMINIZED STEEL (Type 2) offers the same high reflectivity of radiant heat as aluminum—whether from the sun or from low temperature heat sources.

DOES IT RESIST FIRE DAMAGE?

Armco ALUMINIZED STEEL has excellent resistance to fire damage. At 800 F, for example, it has more than ten times the strength of aluminum. Steel has a melting point of 2850 F; aluminum melts at about 1200 F.

WHAT ABOUT FABRICATION?

Armco ALUMINIZED STEEL (Type 2) withstands severe forming without peeling or flaking of the coating. It also can be embossed and spun, but is not recommended for drawing operations.

HOW DOES IT COMPARE IN COST?

Even when considering equal thicknesses, ALUMINIZED STEEL (Type 2) generally costs less per square foot than aluminum. Additional cost savings are possible because the greater strength of the steel base permits use of lighter gages. For example, a fabricator using .050 aluminum could save 40 to 50 per cent of material costs by utilizing the proper gage of ALUMINIZED STEEL.

While the initial cost is somewhat higher than galvanized steel, it is less than the cost of galvanized plus one field coat of paint. Because of its superior atmospheric corrosion resistance, the new aluminum-coated steel needs no paint protection.

If you would like complete information on sizes, gages and prices of Armco ALUMINIZED STEEL (Type 2), just fill in and mail the coupon.

ARMCO STEEL CORPORATION
975 Curtis Street, Middletown, Ohio

Sheffield Steel Division • Armco Drainage & Metal Products, Inc. • The Armco International Corporation

ARMCO®

ARMCO STEEL CORPORATION, 975 Curtis Street, Middletown, Ohio
What are sizes, gages and prices of Armco ALUMINIZED STEEL (Type 2)?

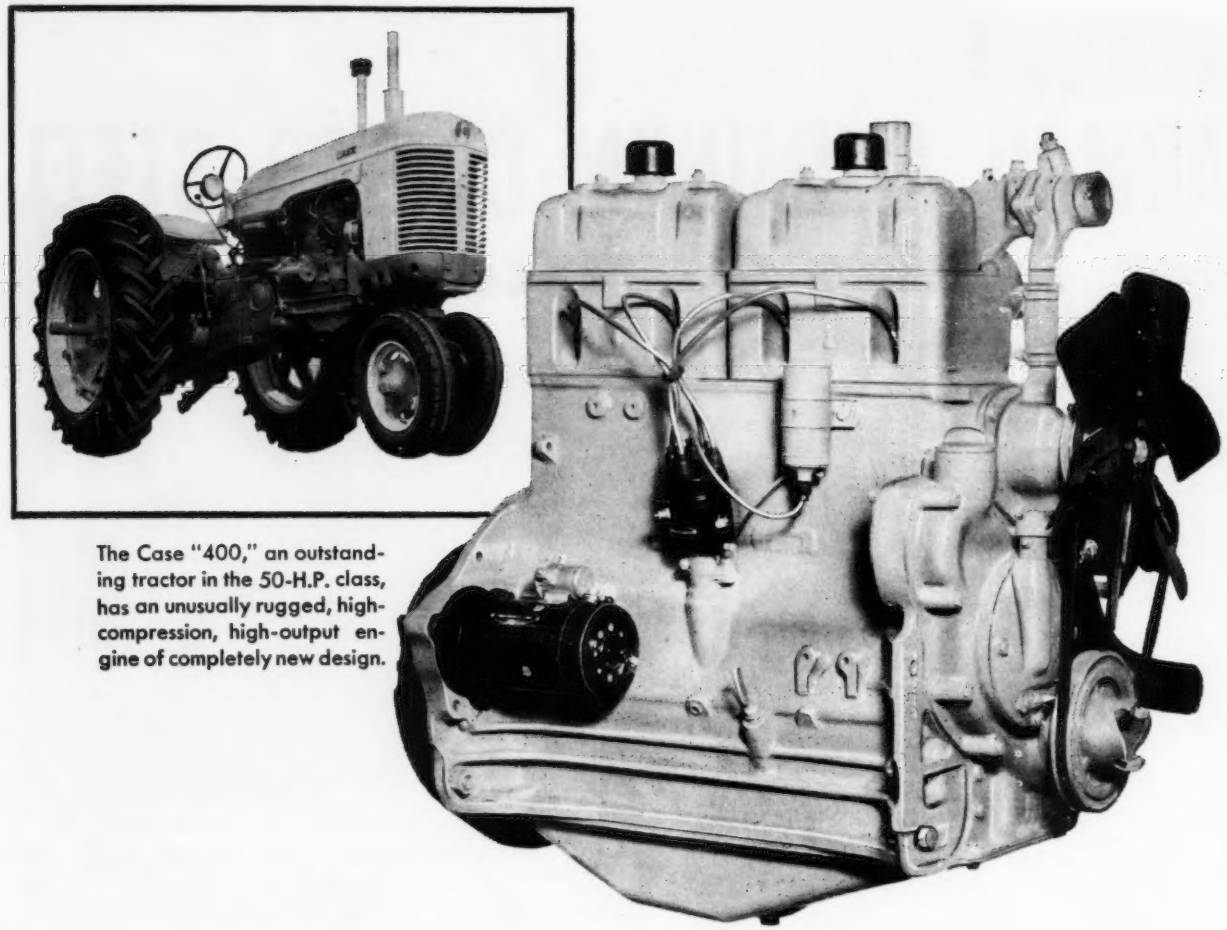
We manufacture_____

Name_____

Title_____ Company_____

Street_____

City_____ Zone____ State_____



The Case "400," an outstanding tractor in the 50-H.P. class, has an unusually rugged, high-compression, high-output engine of completely new design.

Gasoline engine of new design gives high performance in Case "400"

The new Case "400" tractor is causing quite a stir in the farm field. It has many new design features, but the real excitement stems from its completely new gasoline engine that takes greater advantage of today's high-quality gasolines.

The "400" is a high-output engine designed to deliver high performance, economy and long life. It has an extra-heavy cylinder block, five main bearings for added rigidity, modern combustion-chamber design, and greatly improved manifolding. In addition, stepped-up compression ratio results in increased efficiency.

Although the new engine has not been given the Nebraska standard series of field tests, recent laboratory work gives a hint at its outstanding performance. Its high horsepower per cubic inch promises excellent fuel economy and more power out of every drop of gasoline.

Today's modern gasolines offer the greatest power potential of any farm fuel. The Case "400" is another example of efforts by tractor manufacturers to more fully utilize this potential.

ETHYL CORPORATION

NEW YORK 17, N.Y.

This advertisement is one of a series published by Ethyl Corporation to highlight recent advances in gasoline engines by various tractor manufacturers.

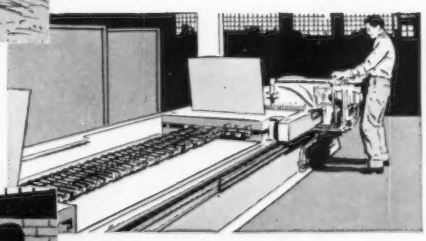
CHAIN is important to the good name of your machine...

ANY SHORTCOMING in machine performance —whatever the cause—reflects on the maker. That's why so many farm machinery manufacturers standardize on Link-Belt chain for long life and added dependability. Exact manufacturing controls and thorough testing assure maximum chain strength and uniformity . . . contribute to the overall quality of your machine.

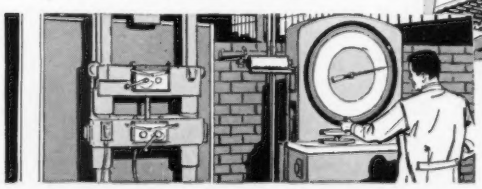
so it's good business to rely on LINK-BELT

COMPLETENESS ASSURES LOW-COST, PRACTICAL ANSWERS. With Link-Belt's broad lines of chain, sprockets and attachments, farm machinery manufacturers are sure to find the right answer for each application.

EXPERT ENGINEERING AND FIELD TESTING. Link-Belt's engineering staff is unequalled in ability and experience. Design innovations are continually recommended and thoroughly field-tested. Many universally-used chain developments were born at Link-Belt.



ACCURATE MANUFACTURE. In the world's largest chain plant — modern, specialized machines allow the economies of large-scale production without sacrificing accuracy. In addition, continuous inspection safeguards tolerances and finish of every length of chain. Next time you face a drive or conveying problem, call your nearest Link-Belt office.



LABORATORY CONTROL. To assure uniform high quality, every Link-Belt chain must conform to exact specifications. Our modern laboratory studies construction refinements to improve chain life, complementing the design research of our engineers.

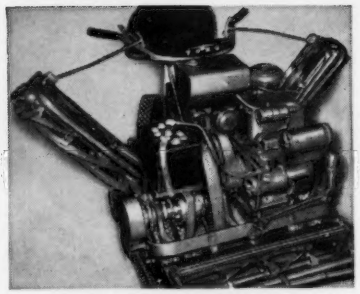
LINK-BELT

CHAINS and SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,717

On Leading Mowers and Sharpeners . . .

DIAMOND ROLLER CHAINS



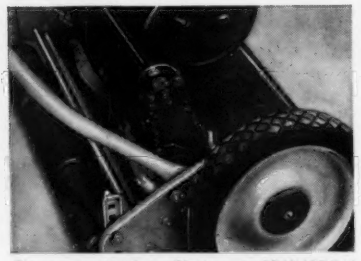
On various models of TORO Mowers made by Toro Mfg. Co.

Diamond Roller Chains Assure Maximum Efficiency for the Life of the Drive!

Rolling at all points of contact, Diamond Roller Chains eliminate separating forces, slippage power loss and waste—deliver nearly 100% of the power from driver to driven shaft.

Uniform highest quality has made Diamond Roller Chains the first choice on leading mowers and sharpeners year after year.

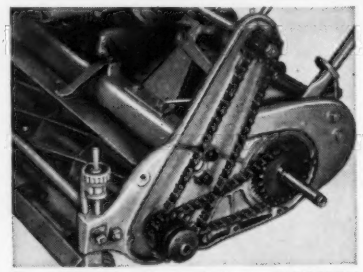
Diamond Engineers are ready to help you solve *any* drive problem. More than 65 years of background in the manufacture and application of Roller Chain is available to you on request.



Close-up showing Chain on JOHNSTON Mower made by Johnston Lawn Mower Corp.

ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.



Two drives from one shaft on JACOBSEN Mower, one of many models made by Jacobsen Mfg. Co.

DIAMOND CHAIN COMPANY, Inc.

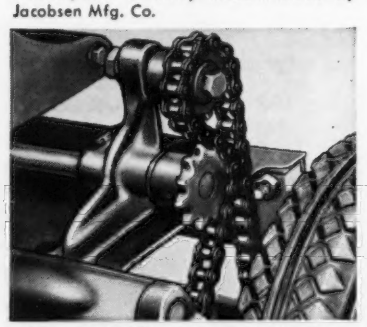
Where High Quality is Traditional

Dept. 616, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

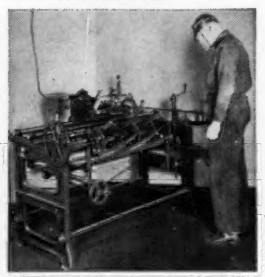
Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

Diamond Chain Drives on IDEAL-PEERLESS Mower Sharpener made by Fate-Root-Heath Co.

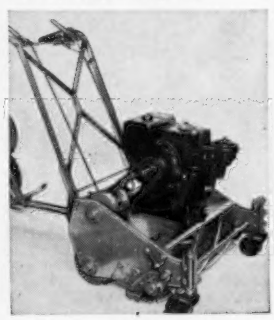


Still another Diamond application on ECLIPSE LARK Mower made by Eclipse Lawn Mower Co.

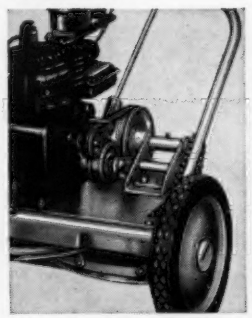
DIAMOND ROLLER CHAINS



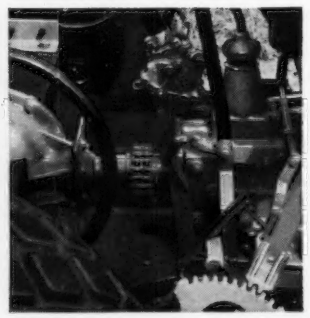
Two Diamond Drives on COOPER Mower, Cooper Mfg. Co.

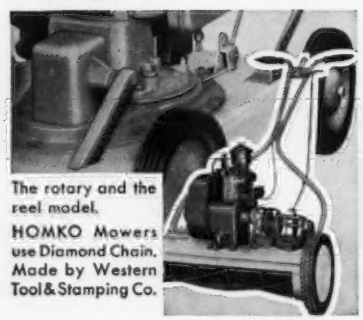


Diamond Chain Drive to blades on HEINEKE Mower made by Heineke & Co.



Diamond Chain Flexible Coupling on WORTHINGTON Mower, Worthington Mower Co.





The rotary and the reel model. HOMKO Mowers use Diamond Chain. Made by Western Tool & Stamping Co.

'We Have No Erosion. Our Land Is Level'

How often you've heard someone say that! It raises a question of who's kidding whom.

How about run-off? Put enough water on "level" land, and it will run somewhere. And when it runs, look out! Flatlands are not damageproof against moving water. (See picture.)

How about the effects of falling water? If a storm dumps an inch of rain on a piece of land, the water strikes with enough energy to plow the soil 10 times. This splash erosion dislodges (and more or less transports) tons of soil, if unprotected, *even on level land.*

How about soil structure? Beating rains can destroy the desirable granular structure of a soil. They pack the soil—hard and tight.

How about puddling, flood water, or standing water? Too much water can be as bad as not enough, and surplus water usually finds its way down from the higher land—to the "flat" bottoms.

How about wind erosion? It's no respecter of level land either.

How about loss of seed, fertilizer, organic matter? Water can carry it away from level land, too.

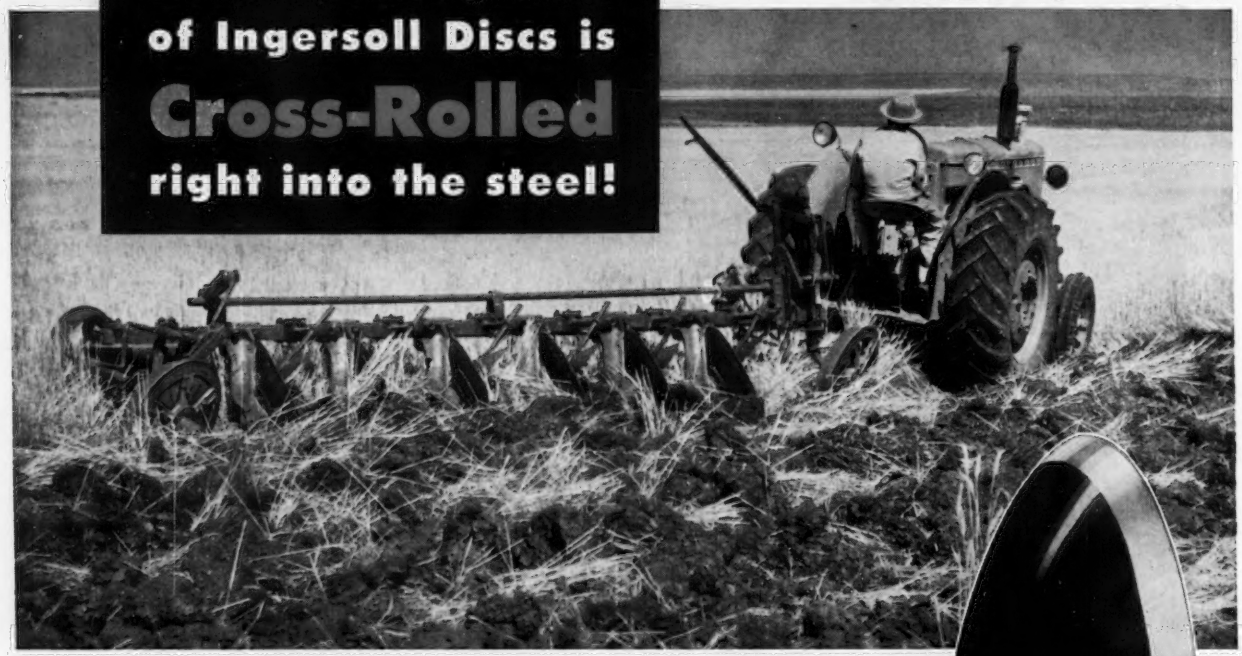
No erosion on "level" land? Don't kid yourself! No matter what your topography may be, you must be constantly alert to the needs of soil maintenance.

JOHN DEERE • Moline, Illinois

Quality Farm Equipment Since 1837

the extra toughness of Ingersoll Discs is Cross-Rolled right into the steel!

Minneapolis-Moline U tractor and TRA disc plow equipped with Ingersoll discs



Greater resistance to impact and fatigue for more acres of trouble-free work!

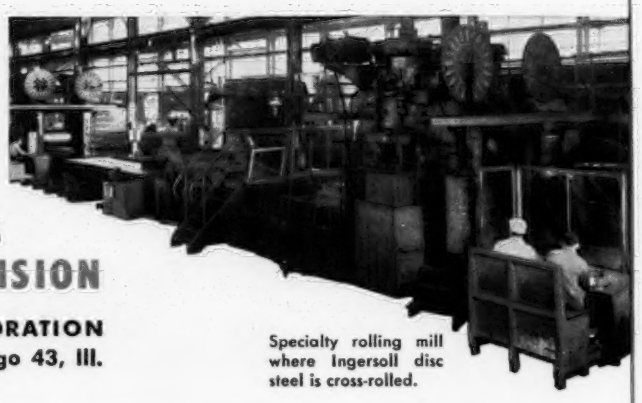
Does cross-rolled steel make a difference in discs? Recent tests at the USDA Tillage Machinery Laboratory conclusively proved that discs from cross-rolled steel were far superior to discs from straight-rolled steel—far more resistant to impact and fatigue. And that means longer disc life—many more acres of useful service.

More than 20 years ago Ingersoll developed TEM-CROSS® cross-rolled steel exclusively for Ingersoll discs. Produced on our own specialty rolling mill, this super-tough steel has a cross-grained structure that resists splitting under impact—stands up under the shock and strain of hard field use.

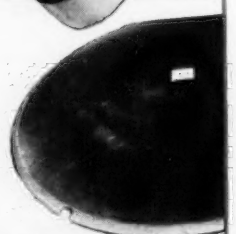
That's one of the big reasons why all leading implement makers equip their tillage tools with Ingersoll discs. Minneapolis-Moline is a good example. Ingersoll supplies genuine MM discs, made to Minneapolis-Moline's own specifications. And these discs are available only through authorized MM dealers.

To be sure you get the best discs for the line of implements you sell, order all your replacement discs direct from your implement maker.

Ingersoll *Heat Treated Discs*



Specialty rolling mill where Ingersoll disc steel is cross-rolled.



Cross-rolled disc nicked in the field. No split—disc still usable.

Straight-rolled disc showing field failure. Note split and break.

ENGINEERING B-W PRODUCTION

INGERSOLL PRODUCTS DIVISION

BORG-WARNER CORPORATION
1000 West 120th St., Chicago 43, Ill.

SPECIALISTS IN TILLAGE STEEL • WORLD'S LARGEST MANUFACTURER OF DISCS

AGRICULTURAL ENGINEERING

VOL. 36 JULY, 1955 NO. 7

Power Distribution and Requirements of a Flail-Type Forage Harvester

C. W. Bockhop and Kenneth K. Barnes
Member ASAE Member ASAE

THE flail-type forage harvester is one of several implements that have recently appeared in the farm implement trade as a possible answer to the need for a lower cost forage-harvesting machine that will produce an ensilage or grass product that is comparable to that provided by conventional forage harvesters. The initial cost, about 60 to 80 percent of the initial cost of conventional harvesters, plus the versatility of the unit, resulting in potentially more annual use, places it in an attractive lower-cost-per-acre category.

The flail-type forage harvester

The flail-type forage harvester is an outgrowth of a type of stalk shredder, and all present machines of such a type can be used for shredding stalks as well as for the production of ensilage, chopping hay and other uses. At the present time, flail-type forage harvesters are marketed by at least five companies. The machines used in this test were furnished by The Lundell Manufacturing Company of Cherokee, Iowa, and are available in two models, the standard and the economy model.

The standard model flail-type harvester

The standard model utilizes a cutting unit to shred and lacerate the material and an auger and fan to convey the material to the wagon. A view of the standard model harvester used in this test is shown in Fig. 1.

The cutting unit consists of forty free-swinging hammers mounted on a shaft rotating about an axis perpendicular to the direction of travel. A flow diagram for the standard model is shown in Fig. 4. The material is cut and carried over the shaft and against the housing and delivered into an auger trough which moves the material to a centrally located fan which transports the material to the wagon. Two concave bars in the housing retard the flow of material for further shredding and laceration before entering the auger unit.

The economy model

The economy model used in this study is shown in Fig. 2. This model uses the same basic cutting unit as the standard model but a different cutting hammer is utilized. The two cutting hammers are shown in Fig. 3. The economy model employs a cup-shaped hammer which cuts and shreds the grass or hay and immediately impells the material to the wagon as shown in the flow diagram in Fig. 5. No concave bars are used in the housing to retard the flow of material; as a result, a somewhat longer length of cut is found with the economy model.

Length of cut

Cowan (3)* compared the length of cut of the conventional harvester, the Lundell standard and the Lundell economy and found the differences as shown in Fig. 6. The mean length of cut was 0.8 in for the conventional, 2 in for the Lundell standard and 2.94 in for the economy.

Purpose of the study

The objectives of this study were:

1 To analyze the power requirements of the three operating components of the flail-type forage harvester

2 To acquire information regarding the peak torques imposed by the components of the harvester

3 To establish a level of requirement for a power unit for the flail-type forage harvester.

Paper prepared expressly for AGRICULTURAL ENGINEERING. Contributed as Journal Paper No. J-2769 of the Iowa Agricultural Experiment Station, Ames, Project No. 1160.

The authors—C. W. BOCKHOP and K. K. BARNES—are, respectively, associate and professor of agricultural engineering, Iowa Agricultural Experiment Station.

Acknowledgment: The authors express their appreciation to Vernon J. Lundell and The Lundell Manufacturing Company for the machines provided for this study.

*Numbers in parentheses refer to the appended references.

Fig. 1 *(Left)* The standard model flail-type forage harvester

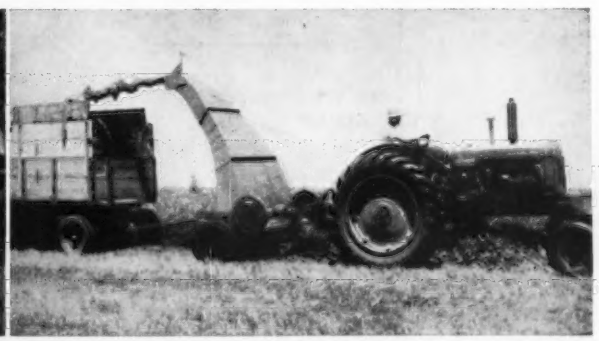


Fig. 2 *(Right)* The economy model flail-type forage harvester.

Instrumentation and procedure

To determine the power requirements of the operating components, electric resistance strain gages of the C7 type were mounted on rotating shafts. Since both ends of the cutting unit shaft are driven, gages were mounted on each end. The gages were also mounted on the auger shaft and the fan shaft. Mercury-bath collector units similar to the ones used by Blevins (1) and Burroughs (2) in work with other agricultural machines were used to carry the signal from the rotating shaft to the instruments. Two Brush amplifiers and a two channel recording oscillograph were utilized to record the torque readings. One channel of the oscillograph was equipped with an event marker which was placed in series with a six-volt battery and a set of points located on the collector unit. A cam lobe on the collector unit shaft actuated the points so that shaft revolutions were recorded. With the recording paper speed known, the shaft rpm was calculated; and with the recorded torque, the required horsepower was determined. So that the resulting power required could be expressed as a function of the rate of feed, the weight of the material harvested in each test and the total time of test were recorded. Tests of the standard and economy models were conducted in two crops, a heavy stand of alfalfa and a rank growth of sweet sudan grass up to 90 in tall.

No load fan test

So that a curve of the fan horsepower as a function of shaft speed would be available to determine the theoretical horsepower required by windage, a no-load test at varying fan shaft speed was conducted. Due to the scatter of the data, a linear regression analysis of the logarithmic form of the equation, $P(\text{fan}) = CX^n$, was computed, where P=(fan)horsepower, C=a constant, X=revolutions per second, n=the exponent. This resulted in the plot as shown in Fig. 7 and the equation as follows:

$$P(\text{fan}) = 0.003N^{2.4}$$

The exponent is less than the exponent found by classical mechanics. The plot indicated that, if the speed could have been increased, an increase of curvature may have resulted. This would have resulted in a higher value of exponent. For the range of values, however, the resulting curve will be accurate.

With the aid of the characteristic fan curve the power theoretically consumed by windage can be determined using the shaft speed for each test and finding the corresponding

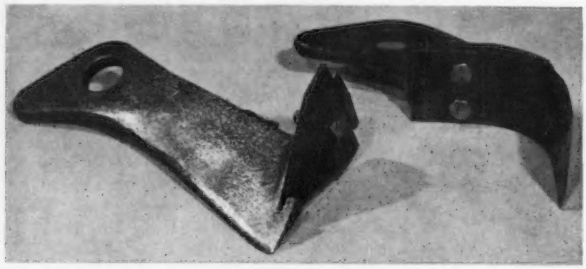


Fig. 3 The standard model cutting unit (left) and the economy model hammer

power consumed by windage. This resulted in the following equations:

For alfalfa

$$P(\text{windage}) = 2.9 - (1.3)(10^{-3})F$$

P(windage) = windage horsepower at feed rate F

F = rate of feed in pounds per minute

For sudan grass

$$P(\text{windage}) = 2.74 - (0.44)(10^{-3})F.$$

In alfalfa, the rpm decreased as the rate of feed increased to a greater degree than in sudan grass. As a result, the theoretical windage power for the two crops will vary as a function of the feed rate as in the above equations.

The horsepower required by the friction of the material against the fan housing was theoretically determined from the following equation:

$$P_f = \mu\alpha N^2 R^2 F \ (3.71)(10^{-5})$$

where μ = coefficient of friction = 0.5 (reference 6)

α = angle that material is in contact with the housing ($\pi/2$ radians)

N = rotational velocity (16.1 revolutions per second average)

R = radius (1.3 ft)

F = rate of feed in pounds per minute

P_f = friction horsepower.

This results in the following equation for the Lundell standard model fan:

$$P_f = (12.55)(10^{-3})F \text{ horsepower}$$

The power consumed due to change in kinetic energy of the material can similarly be shown to be

$$P(\text{kinetic energy}) = 8(10^{-3})F \text{ horsepower}$$

for the Lundell standard harvester.

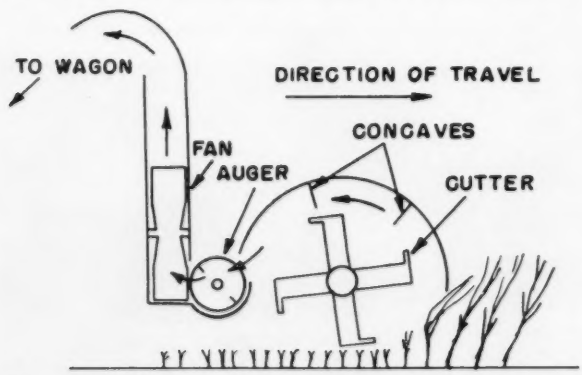


Fig. 4 *(Left)* Flow pattern of the standard model flail-type forage harvester

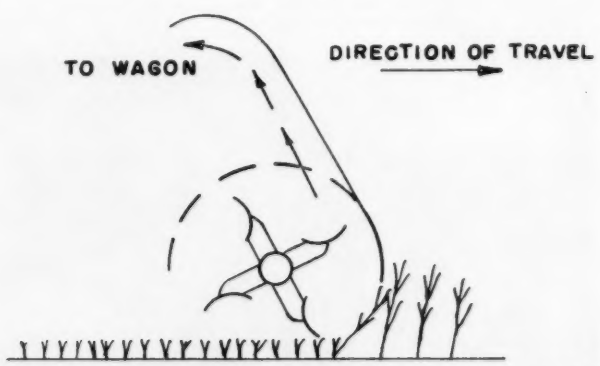


Fig. 5 *(Right)* Flow pattern of the economy model flail-type forage harvester

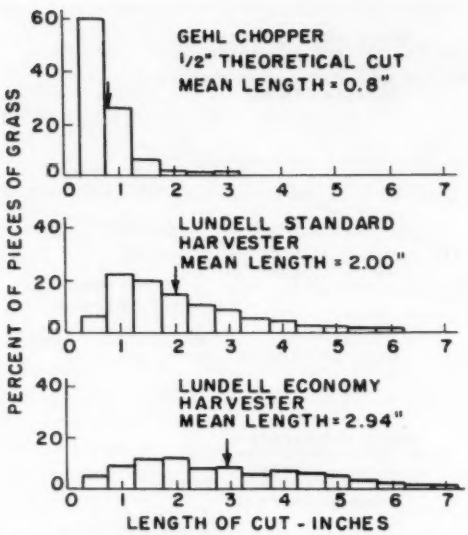


Fig. 6 Frequency graph comparing the length of cut of a conventional flywheel-type harvester, the standard flail-type harvester, and the economy flail-type harvester

The total horsepower theoretically required by the fan is equal to the sum of the windage, friction, and kinetic-energy horsepower. This resulted in the curves in Fig. 8 and the following equations:

For sudan grass

$$P(\text{fan}) = 2.74 + 20.11(10^{-3})F$$

For alfalfa

$$P(\text{fan}) = 2.9 + 19.25(10^{-3})\text{F}.$$

The difference between these two equations is a result

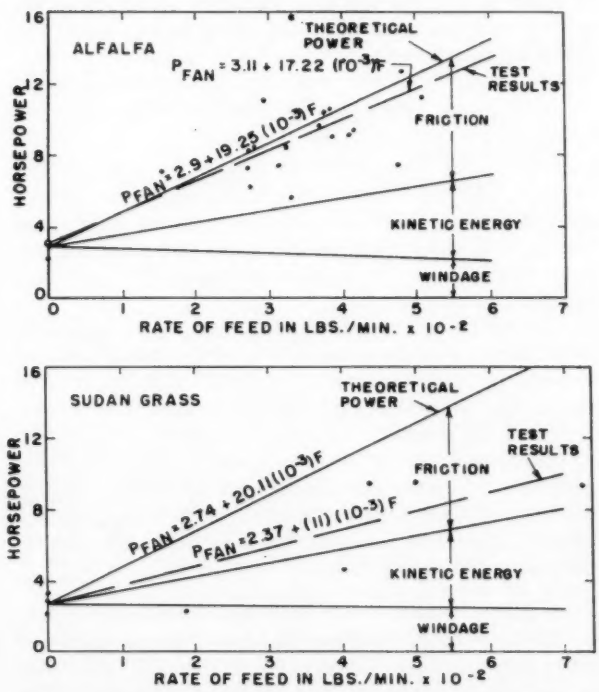


Fig. 8 The power required by the fan in field tests compared with a theoretical analysis

Fig. 7 Power curve characteristic of the standard model fan

of the difference in power theoretically required by windage in the two crops.

The theoretical requirements of a fan are expected to be higher than the actual power required. The theoretical analysis is based on the following assumptions:

1 There is no throttling of air. Actually at high capacity it is conceivably possible to have complete throttling of air.

2 Friction power is based on the normal force or centrifugal force of the material against the housing. All the material is assumed to exert this force for the entire 90 deg of rotation. Actually some rotation will be required before the material picked up on the inner portion of the fan exerts a force against the housing.

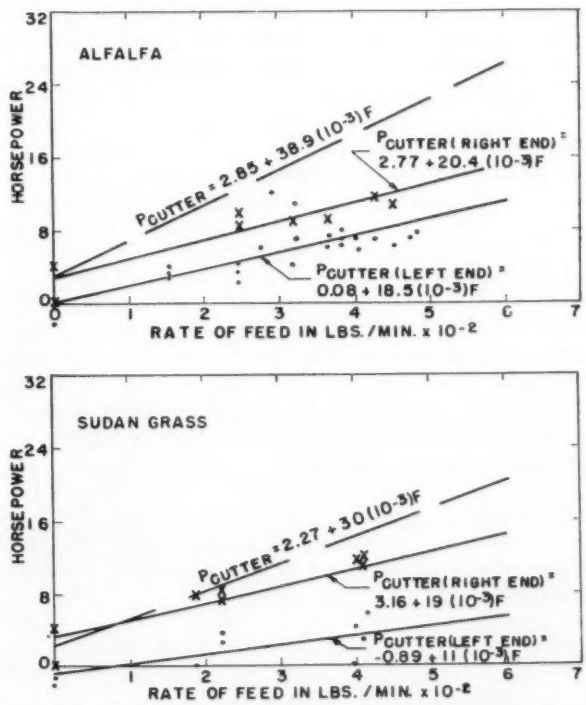
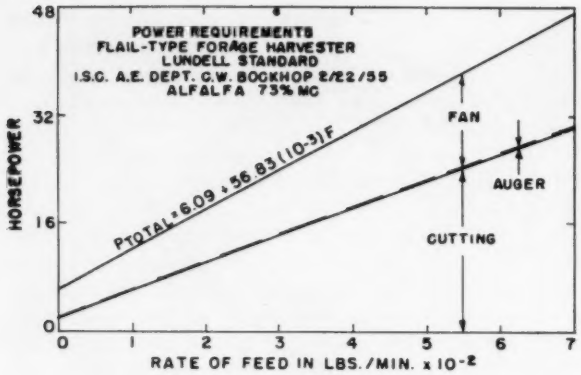


Fig. 9 The power required by the standard model cutting unit



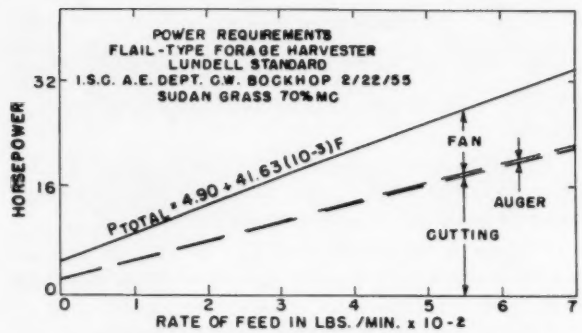
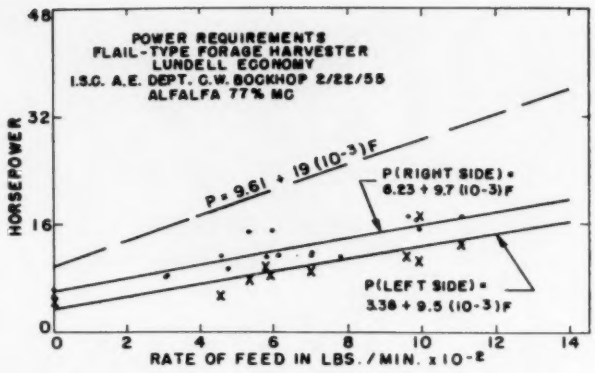


Fig. 10 The total PTO power required by the standard model harvester


POWER REQUIREMENTS
FLAIL-TYPE FORAGE HARVESTER
LUNDELL ECONOMY
I.S.C. A.E. DEPT. C.W. BOCKHOP 2/22/55
ALFALFA 77% MC
HORSEPOWER
RATE OF FEED IN LBS./MIN. x 10-2
P = 9.61 + 19 (10-3)F
P(RIGHT SIDE) = 6.23 + 9.7 (10-3)F
P(LEFT SIDE) = 3.38 + 9.5 (10-3)F

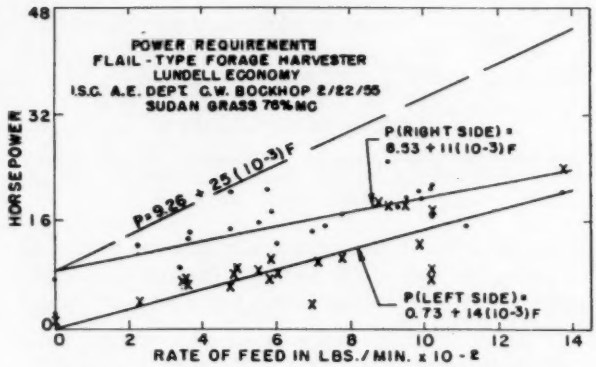

POWER REQUIREMENTS
FLAIL-TYPE FORAGE HARVESTER
LUNDELL ECONOMY
I.S.C. A.E. DEPT. C.W. BOCKHOP 2/22/55
SUDAN GRASS 76% MC
HORSEPOWER
RATE OF FEED IN LBS./MIN. x 10-2
P = 9.26 + 25 (10-3)F
P(RIGHT SIDE) = 8.53 + 11 (10-3)F
P(LEFT SIDE) = 0.73 + 14 (10-3)F

Fig. 11 The power required by the economy model harvester

FIELD RESULTS FOR THE STANDARD MODEL

The fan

The actual field results for the power required by each operating component were plotted and an analysis of linear regression was computed for each curve. The results for the fan are shown in Fig. 8 and can be summarized as follows:

Actual results in alfalfa

$$P(\text{fan}) = 3.11 + 17.22(10^{-3})F$$

Actual results in sudan grass:

$$P(\text{fan}) = 2.37 + (11.00)(10^{-3})F$$

The field results for alfalfa are less than the theoretical by the probable amount of decrease in windage power due to air throttling. The results in sudan grass, however, are much less than the theoretical results. There is an obvious error in the assumption of 0.5 for the coefficient of friction for sudan grass. The coefficient used was that for alfalfa since no data was available for the sudan grass. This points to the need for more study in the subject of friction coefficients for various materials.

The auger

The auger shaft was found to require less than one horsepower at all feed rates in both crops. The resulting equations were:

In alfalfa

$$P(\text{auger}) = 0.13 + 0.71(10^{-3})F$$

In sudan grass

$$P(\text{auger}) = 0.26 + 0.63(10^{-3})F.$$

The cutting unit

The linear regression analysis of the data for the cutting unit resulted in two curves, one for each end of the shaft. The sum of the two was the total power consumed by the cutting unit and resulted in the curve in Fig. 9 and the following equations:

For alfalfa

$$P(\text{cutter}) = 2.85 + 38.9(10^{-3})\text{F}$$

For sudan grass

$$P(\text{cutter}) = 2.27 + 30(10^{-3})F.$$

Since the power required by the fan is less in sudan grass than in alfalfa, due to the smaller coefficient of friction, the same reasoning can be applied to explain the results for the cutting unit.

The total power required by the cutting unit includes the power required by the actual cutting of the stalk, the power required to further lacerate the material as it is carried to the auger, the power required by the change in kinetic energy of the material, and the power required by friction of the material against the cutting-unit housing. Since the material is in contact with the housing for almost 180 deg, the friction power becomes an important factor. It was not possible, in this test, to separate these variables and ascertain the power required by each.

Total power requirements of the standard

The total PTO power requirements of the standard harvester in two crops is plotted in Fig. 10 with the breakdown of the power required by each operating component. The resulting equations are:

For alfalfa

$$P(\text{total}) = 6.09 + 56.83(10^{-3})F$$

For sudan grass

$$P(\text{total}) = 4.90 + 41.63(10^{-3})F.$$

It is noted that 67 percent of the total power required by the standard model harvester is consumed by the cutting unit.

FIELD RESULTS OF THE ECONOMY MODEL

The total power required by the economy model harvester is shown in Fig. 11. The elimination of the auger and fan and the unique design eliminating most of the friction of the material against the housing has resulted in a power curve having less slope than the similar curve for the standard model. The economy model also had a high field capacity. Tests were conducted with up to 1373 lb per min rate of feed with no sign of machine clogging.

The resulting equations for the economy model are:

For alfalfa

$$P = 9.61 + 19(10^{-3})F$$

For sudan grass

$$P = 9.26 + 25(10^{-3})F.$$

It is noted that the economy model harvester required less power in alfalfa than in sudan grass while the alfalfa required the most horsepower when harvested by the standard model. The reason undoubtedly lies in the fact that the design of the economy model eliminates a considerable amount of friction of material against the fan housing and cutter housing. Alfalfa has a higher coefficient of friction than sudan grass and more power is thus consumed by the standard model in alfalfa. Since this friction is not present in the economy model, we can expect the power required to be primarily a function of the power required by the change in kinetic energy of the material and by the power required to cut and lacerate or shred the crop.

Comparison of the flail-type harvester with conventional forage harvesters

Blevins (1) conducted tests with the Allis-Chalmers cylinder-type, the Gehl flywheel-type, and the Case flywheel-type forage harvesters. A comparison of the total power required by the conventional and flail-type harvester for various rates of feed in alfalfa are shown in Table 1.

TABLE 1. COMPARISONS OF THE TOTAL PTO POWER REQUIRED BY THE STANDARD MODEL AND ECONOMY MODEL FLAIL-TYPE FORAGE HARVESTER AND THREE CONVENTIONAL-TYPE FORAGE HARVESTERS OPERATING IN ALFALFA

Machine	Total PTO HP at 300 lb/min	Lb/min per HP	Total PTO HP at 500 lb/min	Lb/min per HP
Lundell standard*	23.5	12.8	34.5	14.5
Lundell economy†	15.5	19.4	19.2	26.1
Allis-Chalmers cylinder-type‡	6.5	46.1	10.2	49.0
Case fly-wheel type‡	19.0	15.7	28.5	17.6
Gehl fly-wheel type‡	14.5	20.7	22.0	22.7

*For values see Fig. 10. The Lundell standard has a mean length of cut of two inches (Fig. 6).

†For values see Fig. 11. The mean length of cut was 2.94 in (Fig. 6).

‡See Blevins (1). The values are total power required, including power required by the feed table. Length of cut for the A-C is 2.25 in; Case, 1.02 in, and Gehl, 0.79 in.

ACCELERATION TESTS

Acceleration tests were conducted by rapidly engaging the power-take-off clutch with the tractor throttle set at maximum. Tests were conducted with two tractors, a Cockshutt 40D and a Case 500 diesel. The torque was measured at each shaft and from this the total torque at the PTO was computed. Up to 16,970 in-lb of torque was found to develop at the PTO shaft when the Cockshutt 40D was used, while the use of the Case 500 diesel resulted in a maximum torque of 5,940 in-lb. The peak torque obtained with the Cockshutt 40D was comparable to that found by Hansen (5) when testing conventional harvesters. The difference between results with the Cockshutt tractor and the Case tractor emphasizes the fact that peak torques developed are a function of the characteristics of the tractor and tractor PTO clutch as well as the driven machine.

SUMMARY

The standard model flail-type harvester used in this test will generally require a 3-4 plow tractor for a power unit. The power requirement is relatively high compared with conventional-type forage harvesters. The standard model harvester has a capacity comparable to conventional harvesters in a normal working range (300 to 500 lb per min rate of feed) and is a machine of simple design with relatively few working parts and can be utilized as an ensilage harvester, hay and straw chopper, stalk shredder, weed cutter, beet topper and many other possible uses. It can probably be used economically by a farmer who uses an ensilage harvester an average number of hours per year and who already has a 3-4 plow tractor.

The economy model can be powered by a 2-3 tractor at relatively low operating capacity but will need a 3-4 plow tractor to maintain a high capacity. The power required is comparable to that required by conventional harvesters at average working capacity but relatively lower at a high working capacity. The economy model had a field capacity higher than the standard model or conventional harvesters due to its simple design utilizing the most direct path from the standing crop to the wagon.

The economy model is as versatile as the standard model in its application but has fewer working parts. The end product of the economy model is longer than the standard model, but where the longer length of cut is no objection, the economy model should find acceptance. Farmers and stockmen who utilize a green-feeding practice, for example, should find the high operating capacity and simple design ideally suited to their operations.

References

1 Blevins, F. Z. Some of the component power requirements of field type forage harvesters. Unpublished M.S. thesis. Lafayette, Indiana. Purdue University Library. 1954.

2 Burroughs, D. E. Power and torque distribution in farm machine drive shafts. AGRICULTURAL ENGINEERING 34:382-384, 386. 1953.

3 Cowan, Andrew M. Evaluation of shredding as a pretreatment of grass for silage. Unpublished M.S. thesis. Ames, Iowa. Iowa State College Library. 1955.

4 Dobie, W. B. and Isaac, P. C. G. Electric resistance strain gauges, pp. 93-94. London. The English Universities Press, Ltd. 1948.

5 Hansen, Merlin. Loads imposed on power-take-off shafts by farm implements. AGRICULTURAL ENGINEERING 33:67-70. 1952.

6 Shinke, R. Coefficient of sliding friction for corn and alfalfa on steel. Report No. 3-A186G-52R1. Chicago, Illinois. Advanced engineering department, International Harvester Company. 1952.

Mechanical Feeding of Livestock

John B. Dobie
Member ASAE

The mechanization of the feeding of farm animals involves the essential operations of moving in, storing, processing, and moving out the feed in the proper form for livestock consumption. This paper deals with important items of equipment used in mechanical feeding

DEVELOPMENT of mechanical livestock feeding has been largely on a trial-and-error basis. Basic information on the handling characteristics of some feed materials is largely lacking – information that might be applicable in designing new equipment and improved installations. Part of the equipment described in this paper has been designed to be flexible in application, readily fitting into various installations despite a lack of such pertinent information.

A livestock enterprise is usually developed around a central physical plant or set of buildings (1)*. Feed must be moved in, stored, processed, and moved out in the proper form for consumption by livestock. The mechanization of any part of this process is closely associated with mechanical feeding. The problems involved include the form in which feed is received at the feeding plant.

Forage in some form is a basic feed for most livestock, especially cattle, and is of such bulk and weight that labor costs for handling are considerable. For these reasons forage has an important place in mechanical feeding investigations. Production of forage is preliminary but related to livestock feeding. The relative merits of producing and feeding forage as dry hay, pasture, silage, and green-chopped hay (soilage) are being studied intensively. Recent tests at the University of California at Davis (2) have produced approximate weight gains from three different methods of feeding – pasturing, green feeding, and dry-hay feeding – of, respectively, 600, 1000, and 800 lb of beef per acre. Although green feeding produced substantially greater gains per acre of feed and dry-hay feeding placed midway between the other two systems, differences as to cost of labor, equipment, and production may largely equalize the returns. Some farmers who are experienced in green feeding have been able to replace 75 percent of their soilage with good-quality dry hay without reducing milk production. Except for special conditions, dry hay remains the standard feed for cattle.

Barn-Filling Conveyors

Pneumatic conveying, long in widespread use for moving hay and silage, has certain advantages, as indicated by Kleis (3) and Terry (4). However, where the pneumatic conveyor has been replaced with a mechanical conveyor, the power requirement is reduced as much as 80 percent for a given capacity and the quality of dry chopped hay is superior because of less leaf shatter and separation. A 2- to 5-hp motor is used to drive barn-filling conveyor, which is 2 to 3 ft wide and operates at a lineal speed of 75 to 100 fpm. Two-foot-wide conveyors, with capacity of 15 to 20 tons per hour, are driven with a single, heavy link belt or combination chain, with 2 x 3-in cross flights spaced 2 to 3 ft apart. The hay is elevated from the wagon-unloading table through a 45-deg angle to a horizontal conveyor a few feet below the roof ridge. The hay drops through square holes spaced 7 to 8 ft apart along the bottom of the conveyor. The drop-through holes are as wide as the conveyor and have removable covers to permit filling any part of the barn. The conveyor may return either over or under, but either way must provide not less than an 18-in clearance. This type of conveyor is preferred to a belt conveyor because of its low cost and easy unloading.

Similar equipment is used for filling upright silos (Fig. 1). For silage, a 42-ft elevator, set out 18 ft from the bottom of the silo, will elevate into a silo 35 ft high. A conveyor with 2 x 4-in cross flights fastened to a single No. 67 malleable chain travelling 260 fpm has ample capacity to handle the output of a field forage chopper working steadily. The elevator is powered by a 5-hp electric motor.

Fig. 1 Silo-filling elevator, powered by a 5-hp motor, elevating corn silage

Barn-Unloading Conveyors

With large dairies and beef feedlots, hay is usually moved from the storage area to another location for feeding. Flight conveyors are used to remove chopped hay from the barn and transport it to the feed-mixing plant or feed-distribution system. The conveyor is placed in the bottom of the hay-drier duct, which is constructed in such a way that the sides of the duct are removable in sections. A framework supports the top of the hay-drier duct and the movable side panels are attached to the frame from the inside, permitting removal regardless of hay load. For removing hay from the barn, the panels are removed one or two at a time so hay can be pulled into the conveyor.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Rural Electric Division.

The author—JOHN B. DOBIE—is associate specialist in agricultural engineering, University of California (Davis).

*Numbers in parentheses refer to the appended bibliography.

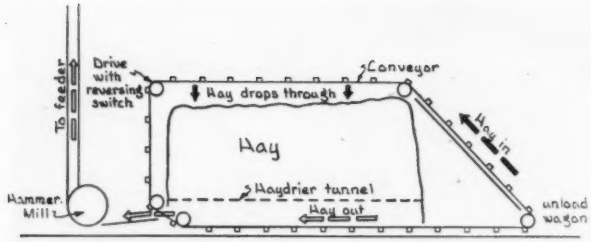


Fig. 2 Schematic drawing of conveyor used both to load and unload the hay at the barn

The conveyor is similar to the one just described—in fact, may be an extension of the barn-filling conveyor as shown in Fig. 2. In one such installation in a barn 200 ft long, the conveyor return extends down the end of the barn and back along the bottom of the drier duct to the wagon unloader. The hay is removed from the end of the barn opposite from that where it is brought in; hence the conveyor is reversible. A 3-phase 3-hp motor with a reversing switch is ample for this size of barn. Two C-77 chains are used on this 3-ft-wide conveyor, with cross flights 3 ft apart. A tightener takes up any slack resulting from elongation in the chain, which might permit the chain to jump a tooth at the drive sprocket. Electric control stations are strategically located for quick accessibility in case of breakage and for operator safety. Safe practice requires two men on the job when the conveyor is in use.

A second installation has an 18-in-wide single-chain conveyor in the bottom of the hay-drier duct, with the return chain underneath (Fig. 3). Cross flights are attached to welded-link chain at 18-in intervals. The chain runs in grooved sprockets similar to V-belt pulleys. Conveyor speed is 180 fpm for this installation, but for others will normally range from 125 to 150 fpm, depending on the ability of the operator to keep the conveyor loaded and, more important, the capacity of the feeder or mixing plant into which the conveyor deposits its load.

Chopped Hay Feeder

A flight conveyor suspended 4 to 6 ft above a 5-ft-wide feeder is used where free-access feeding of dry hay is practiced (Fig. 4). The bottomless conveyor is centered over the feeder and fills first at one end. Then, as hay builds up to form a bottom in the conveyor, the hay is carried farther along, until the entire feed bunk is filled. Tests indicate that the bottomless conveyor should not exceed 50 ft in length. If it is longer, friction between the hay carried by the conveyor and the hay in the bin below becomes too much for smooth operation. If a longer unit is needed for a large herd, the extra length of conveyor is provided with a wood bottom at the inlet end, hinged from both sides so it can be released to fill the feeder underneath. At the start, the hinged bottom is raised to fill the far end of the feeder first. The feeder is then filled back to the inlet end by dropping a section of the hinged bottom at a time. Any part of the feeder may be filled when the bottom is released and allowed to swing down. Sideboards below the bottomless conveyor control the height of hay in the feeder, extending far enough so that hay will not spill out over the stanchions. The hinged bottom swings down to provide the same control. The space under the conveyor is kept clear of cross braces. A 5-ft-wide feeder that is long enough to allow 2 ft of feeding space per cow will provide ample hay capacity for three days of feeding. Filling time averages about one man-hour for each 30 to 40 ft of feeder.

Fig. 3 Flight conveyor for removing hay from the barn. Panels on the sides of the hay-drier tunnel are removed from the inside so that hay may be pulled into the conveyor by hand

Two No. 62 steel link-belt chains are spaced 12½ in apart for a conveyor 24 in wide, with 2 x 3-in cross flights, spaced 24 in apart, attached with K-1 attachment links. The ends of the cross flights drag on two-by-fours set on edge to provide maximum clearance for the hay to drop through. The return chain should be at least 16 in above the conveyor,

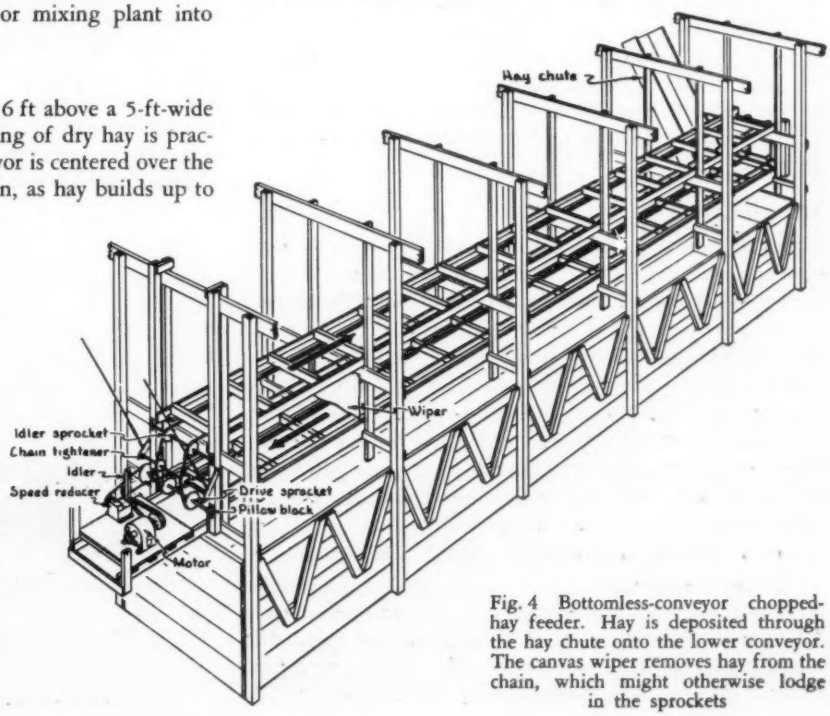


Fig. 4 Bottomless-conveyor chopped-hay feeder. Hay is deposited through the hay chute onto the lower conveyor. The canvas wiper removes hay from the chain, which might otherwise lodge in the sprockets

to keep the hay from rolling between them. Hay is fed in through a chute from one side onto the lower conveyor. A spring-loaded tightener, just ahead of the drive sprockets, takes up any slack resulting from stretch in the chain or "give" in the structure. It is essential that the wooden conveyor frame have ample stiffness lengthwise. The conveyor speed will depend on the capacity of the unit delivering hay to it, but for normal operation ranges from 75 to 100 fpm. The power requirement is about ½ hp for each 35 ft of conveyor. Time-delay overload protection is installed to handle starting load and occasional short-duration overloading from binding in the hay mass.

Mixed Ration Feeder

Mechanical conveyors are being used extensively in California to feed a mixed ration to beef cattle in installations, available commercially, commonly known as one-man feedlots. Ground hay is fed into a continuous mixer by conveyor (Fig. 5). Ground grain, concentrates, and molasses or other binder are added in the mixer. The mixer is a horizontal unit with a rotating shaft. Spiralled around the shaft are mixing fingers that mix and gradually move the mixed feed out the end, where it drops onto the feeding conveyor. This conveyor, which is 400 ft long, carries the feed out between two rows of stanchions, where the cattle eat directly off the conveyor. The feeder trough is 30 in wide and 10 in deep, lined with sheet metal. The conveyor, a single C-77 chain unit with 2 x 3-in wood cross flights, is driven by a 3-hp motor. A three-speed transmission provides flexibility, but normal operating speed is 20 fpm. Since the cattle eat directly off the conveyor, the chain travels only the length of the feeder for any feeding. For a 400-ft feeder the filling time is 20 min. The return chain is above the reach of the cattle, about 6 ft high, carried on sprockets 15 to 20 ft apart. The feeder is covered with a roof that extends over a concrete apron on each side, on which the cattle stand while eating.

Unless sufficient binder (such as molasses) is used there is some tendency for grain and concentrate to sift through the hay and be deposited in the first 50 to 100 ft of the feeder. In such cases the cattle are divided into lots and rotated to assure greater uniformity in the average ration for each animal.

Wheeled Feed Bunk

Hand-pushed movable feed bunks on rails have been used to carry silage to the feedlot, with an estimated labor saving of 60 percent over hand feeding. A train of feed bunks, 5 ft wide, passes under the chutes of twin upright silos 5½ ft apart. Silage thrown down lands in the feed bunks, which are mounted on flanged wheels and are pushed along the rails into the feedyard. Cows eat directly from the feeders, made of 2-in lumber for weight and strength. The operation requires a back track equal in length to the train of feeders. This type of feeder works equally well for mixed-ration feeding, with an advantage over flight conveyors in that there is no separation of the mixture in transit.

To mechanize this type of feeder further, an electric drive was developed at the University of California to move the train in either direction at a predetermined speed that would permit uniform loading by a silo unloader or a feed mixer. (Fig. 6). The drive, midway between the ends of

Fig. 5 Feed mixer and drive unit for one-man feedlot. Hay enters on conveyor (extreme right), travels to the left through the mixer into which concentrates are metered from the hopper above, and drops onto the conveyor at lower left

the track, is located under the bunks and between the tracks, which are 6 to 8 in above the grade to keep them clear of refuse. The drive unit operates on the rack-and-pinion principle. The rack is channel iron with notches cut in the flanges for teeth. The same effect is obtained by welding projections on flat iron. The pinion is a steel linkbelt chain operating between two sprockets 36 in on center. Every seventh link is a K-1 attachment link, with the attachment arms reinforced to serve as teeth of the pinion. The distance between teeth on both rack and pinion is seven times the length of the chain links, e.g., 11.58 in for a No. 62 chain. Two or more sets of teeth are thus always in contact. The rack is fastened under the feed bunks and extends the length of the train, Feed bunks are in units of 16 ft butted togther at the ends and connected by pin couplers in the rack.

A reversing-drum switch is used for manual starts and automatic stops. By adding two or more three-point switches the unit can have remote control. The speed at which the train moves can be varied according to the rate of filling of the feeders but is normally about 20 fpm. For use with a silo unloader or similar device the operation can be tied in electrically, to be completely automatic once it has been started.

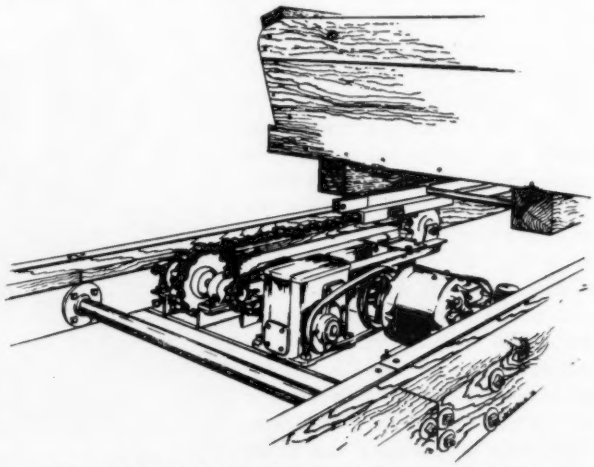


Fig. 6 Rack-and-pinion drive unit for wheeled feed bunks

Mechanical Unloading Wagons

Portable power-unloading wagons are standard equipment for feeding in most large beef feedlots and on many dairies in California. Large feedlots, because of their widespread corral arrangement, lend themselves to the versatility of wagon feeding. The advent of green chopped-hay feeding (soilage) has resulted in the addition of mechanical feeding units to wagons originally designed to haul dry chopped hay, to assist in the daily handling of the wet, heavy material.

Mechanical unloading wagons are used to handle many different types of feed. On a beef feedlot, one wagon may at different times feed chopped green alfalfa, silage, mixed dry feed, grain, beet pulp, or dry chopped hay. The operator adjusts the rate of feeding either by speed control built into the wagon power unit or by varying the ground speed. Front unloading wagons are favored by most operators because they provide better vision of the feed discharge.

Farm feeding wagon boxes are about 6 ft wide, 12 to 14 ft long, and have sides 4 to 6 ft high. They have two conveyors: one is in the bottom of the wagon to move the load to the front end; the other is a cross conveyor at the same end. Farm wagons for handling hay and for feeding usually have a heavy-duty chain with angle-iron cross flights for the bottom conveyor and rough-surfaced rubber belting for the cross conveyor. For mixed dry feed, one to three augers are used in the wagon bottom to move the feed to the end. A moving chain, with short spike teeth mounted in a vertical plane over the cross conveyor, slices the feed off the end of the load as it is pushed forward. Two or more augers or rotating spiked drums are also used for this purpose. Power for unloading the wagon is provided by power take-off or by a gasoline engine mounted on the wagon. Numerous unloading wagons are produced commercially, but the need for heavier-duty equipment for service-free daily operation has resulted in some custom-built units.

Two methods are used to load wagons with a mixed feed ration. The preferred arrangement is to load with a premixed ration from a mixer or bin, so that no mixing is necessary during unloading. In the second system, uniform layers of each feed are spread in the wagon so that the vertical drag or auger above the cross conveyor does the mixing by cutting across the layers. This system requires more care in loading and results in a less uniform ration than the premixed feed, but it does simplify and reduce the cost of the feed processing plant.

Self-feeding Silage

For small herds, recent development has been directed toward trench and stack silos. Movable feed stanchions and feeding floors are gaining in popularity (5) permitting the cattle to eat directly from the pile with a minimum of waste, but optimum conditions have not yet been established. The practice† varies somewhat but general recommendations are:

- For easy feeding, silage should be stacked a maximum of 6 ft deep.
- Allow one stanchion for each 4 to 5 cows.
- Move feedings floors or stanchions forward about 12 in whenever silage within reach is cleaned up, normally 4 to 5 days.
- Slope the stanchion back at the top, 8 in with 5-ft-high stanchions, to keep the cattle eating down toward the bottom of the stack (Fig. 7).
- The floor of the silo should be hard-surfaced.

Feeding Concentrates in the Dairy

Mechanizing the feeding of concentrates during the milking operation makes it possible to save time and many steps. The mechanical systems now in use provide, at the head of each cow, a ready supply of feed that can be released to the cow in a metered amount by turning or pulling a lever from the milking side of the stanchion. The feed is carried to the individual hoppers over the stanchions, either by gravity from a roof-top bulk bin or by a dust-tight overhead auger or drag conveyor (Fig. 8). With bulk delivery of feed to the ranch, concentrate feeding may be completely mechanized. With gravity feed from a roof-top bin, the only farm operation involved is turning the lever, which meters out a fixed amount of feed per turn.

†The author is indebted to Glen Eidman, farm advisor, for information on this farm developed practice.

(Continued on page 466)

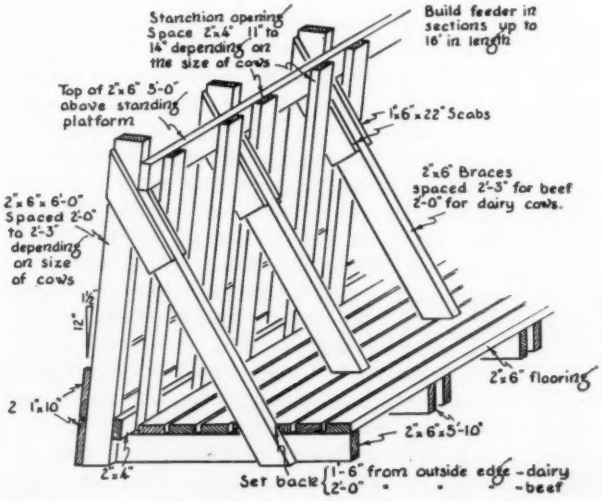

Stanchion opening Space 2"x4" 11" to 14" depending on the size of cows
Build feeder in sections up to 16' in length
Top of 2"x6" 5'-0" above standing platform
1"x6"x22" Scabs
2"x6" Braces spaced 2'-3" for beef 2'-0" for dairy cows.
2"x6" 6'-0" Spaced 2'-0" to 2'-3" depending on size of cows
12"
2 1"x10"
2"x6" flooring
2"x6"x5'-10"
2"x4"
Set back 1'-6" from outside edge - dairy
2'-0" " " - beef

Fig. 7 Trench silo self-feeder, of which the mechanization involves moving the feeder to the feed

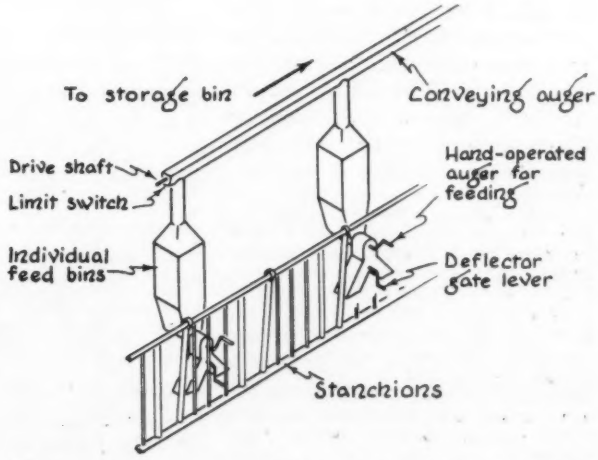


Fig. 8 Mechanical system used to deliver ground feed to individual stanchions in a milking parlor

Non-Linear Air Flow in Grain Drying

W. V. Hukill and C. K. Shedd
Member ASAE Life Fellow ASAE

IN SEPTEMBER 1953 the authors prepared a report (1)* of observations on drying oats with unheated air, which included a description of a method of analyzing data on static pressures to give an estimate of the effectiveness of ventilation at all points in the grain mass. The method was applied to the data from the oat-drying test and seemed to be useful in anticipating the degree of non-uniformity of drying in bins in which the air flow lines are non-linear. The report was not published but was circulated to a number of engineers at various locations who are working on problems in grain drying. Since that time, three additional tests have been made in the same buildings, each of which tends to confirm the usefulness of the method. It is presented here, somewhat revised, together with observations on this and other phases of the tests.

One problem in designing or operating bin driers with heated or unheated air is to approach as nearly as possible a condition in which all air flow paths through the grain are equally effective, and at the same time to keep the cost of the installation at a minimum. It would be helpful to know how much is lost in effectiveness when air is admitted to the grain from spaced openings instead of from a continuous surface such as a perforated false floor.

Minimum ventilation requirements for drying grains of various moisture contents under various atmospheric conditions are most frequently given in terms of cfm per bushel. In using this unit it is implied that the air flow is uniformly distributed through the grain. If the air flow is not uniformly distributed, then obviously the minimum requirement must be increased, so that the least well-ventilated grain gets the equivalent of the necessary air flow.

For some purposes it is convenient to express the ventilation rate in terms of the length of time the air takes to pass through the grain. A given requirement in cfm per bushel may be expressed equally well in terms of traverse time. For example, a ventilation rate of 1 cfm per bu could be described as a traverse time of 30 sec, or 3 cfm per bu as 10 sec. This relation may be verified as follows: One bushel is 1¼ cu ft; for most grains the void space between kernels is approximately 40 percent. Therefore each bushel of grain contains 0.4 x 1.25 = .5 cu ft of air. If one cubic foot of air is passed uniformly through a bushel of grain in one minute, each particle of air must remain in the grain for one-half minute or 30 sec.

$$T = \frac{30}{\text{cfm per bu}}$$

in which T = traverse time in seconds and the air flow is assumed to be uniformly distributed through the grain. This is the traverse time at the surface of the grain where the air exhausts. The traverse time at points within the grain would be less; for example, half way through the mass of grain the traverse time would be 15 sec. If for some reason the air goes through some portions of the grain more readily than through others, then at a given total of cfm per bushel there is a variation of traverse times at various locations. The points where the air takes 30 sec to arrive, for example, are ventilated at the rate of 1 cfm per bushel. Since any point in the bin, including the surface layer, has a definite traverse time, it is convenient to express the effectiveness of ventilation in terms of traverse time rather than in terms of cfm per bushel.

Since traverse time is an expression for effectiveness of ventilation, it would be helpful in evaluating the performance of a given air-distribution system if traverse time could be estimated for all points in the bin. Such estimates can be made by computation, if static-pressure readings within the grain are taken during ventilation and the air-resistance properties of the grain are known.

In the case where the air-flow paths are straight and parallel, as in a bin of uniform depth with vertical sides, and with a perforated floor for admitting air under the whole area, the air velocity and the pressure drop per foot are substantially uniform from the bottom to the top. In this case the traverse time can be computed directly from the difference between entrance and exhaust pressures, the depth of grain, and the properties of the grain, without attention to pressures at intermediate points. On the other hand, in the case of curved or divergent flow lines, such as those from spaced air ducts, the traverse time cannot be deduced from the initial and final static pressures only, but it is necessary to take into account the variations of the pressure gradient along the flow line as well as the length of the flow line.

A series of drying tests under way at the Ames station afforded the opportunity to observe the effect of curved flow lines. The tests were made in quonset buildings which are 16 ft wide, with a central ventilating

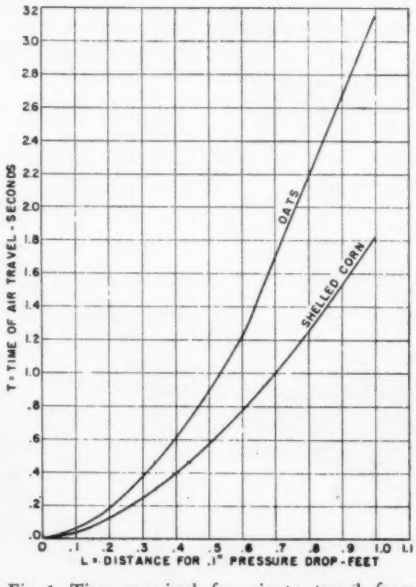


Fig. 1 Time required for air to travel from one pressure line to the next. $\Delta P = 0.1$ in

Paper prepared expressly for AGRICULTURAL ENGINEERING. Approved as Journal Paper No. J-2710 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 587 (USDA cooperating).

The authors — W. V. HUKILL and C. K. SHEDD—are, respectively, principal agricultural engineer in charge of grain-storage investigations and former senior agricultural engineer, farm buildings section, agricultural engineering research branch (ARS), U.S. Department of Agriculture.

*Numbers in parentheses refer to the appended bibliography.

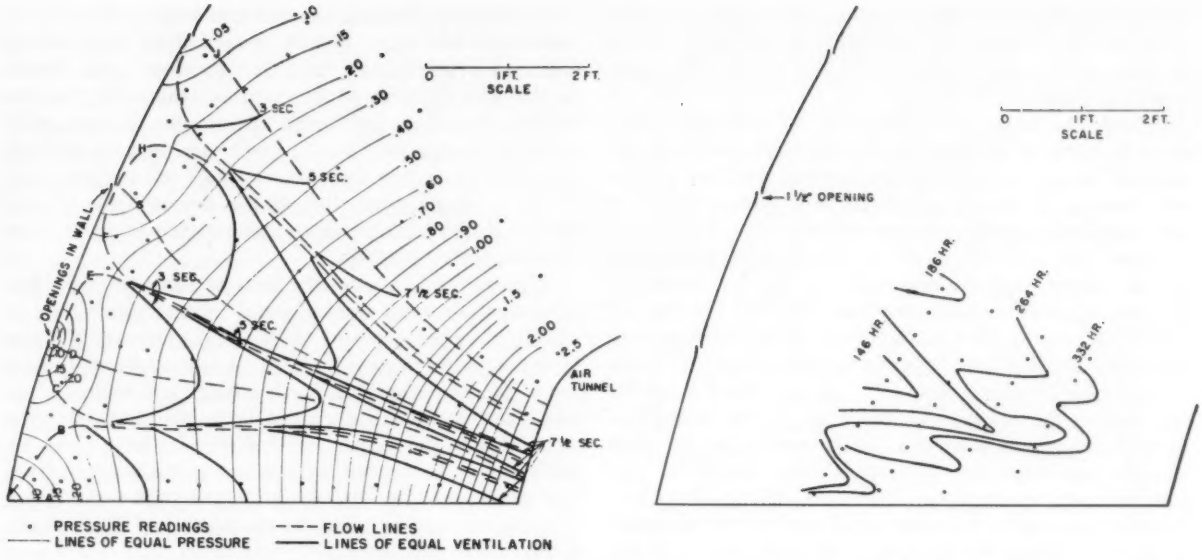


Fig. 2a *(Left)* Air flow in section of oat-drying bin • Fig. 2b *(Right)* Time required to reach 80 percent humidity in oat-drying bin, July 1954

tunnel. The buildings are described in a previous article (2). A plywood wall was erected about four feet from the door end of the building to form a vertical surface against which the grain was loaded. Small holes in the plywood permitted taking static pressure readings at a large number of points in the cross section of the grain.

The first step in the analysis of air-pressure data was to draw a cross section of the bulk of grain to scale, then spot the points where pressure readings were taken. The next was to enter the pressure readings on this chart and draw lines of equal pressure by the same procedure as used for drawing contour lines of a topographical map of a field. It was then possible to draw flow lines on the chart, each flow line crossing each equal pressure line at right angles. Figs. 2a and 3a were constructed in this way. The dots show where pressure measurements were made. The light solid lines are lines of constant pressure. The dotted lines are paths of air flow.

Consider the air moving along one of the dotted flow lines of the chart. Since the fan in the bin exhausts air from the tunnel, the air movement through the grain is toward the tunnel along the flow line. As the air moves along the flow line, the time required to reach the 0.1 in pressure line can be computed. Similarly the time taken to move from the 0.1-in to the 0.2-in lines and that for each successive increment can be computed. The total time in the grain is the sum of all the increment times. If desired, the time required for the air to reach any point in the bin can be estimated. The time required for the air to pass from one pressure line to the next is computed as follows: Measure the distance L (in feet) along the flow line between the pressure lines. Since the pressure lines set off pressure differences of 0.1 in (water gage), multiply the distance L by 10. Then $1/10L$ is the pressure drop in inches per foot of depth. Refer to a pressure-flow chart for oats (3) and read the cfm per square feet corresponding to $1/10L$. This is the apparent velocity, cfm per square foot. Since the grain has 40 percent void space, the average actual velocity is cfm per sq ft/0.4, or 2½ times the apparent velocity. The time to traverse L feet is $0.4L$/cfm per sq ft.

To make a computation as expressed above is laborious but it can be done by a relatively simple graphic method as follows: For any given distance, L, subtending a pressure drop of 0.1 in in oats, the cfm per sq ft, the velocity, and the traverse time are read or computed from the resistance chart. Since for this purpose we are interested only in the traverse time, the latter is plotted on a separate chart, Fig. 1, for various values of L. From Fig. 1 a linear scale is made to fit the scale of the original chart of pressure lines (Fig. 2a) the scale being graduated and labeled in seconds, traverse time. The distances between successive pressure lines on Fig. 2a are then measured with this scale and tabulated for several air flow lines. The time required for air to reach various points in the bin is marked on the charts and points of equal traverse time are connected by a line. Several such lines are shown on the chart (heavy lines in Fig. 2a) and each line is thought to represent points of equal effectiveness of ventilation.

Readings of grain moisture content at various locations in several tests made in these buildings tended to verify the assumption that the lines of equal traverse time are also lines of equal drying effectiveness.

In the early tests in these bins grain moisture content was determined by testing samples withdrawn with a probe. Such readings are not very satisfactory for following the moisture changes in the grain because it is difficult to define the exact location from which the sample is taken, each cell in the probe is not necessarily filled from the grain immediately surrounding it, but since dry grain flows better than wet grain, the cell may be filled by drier grain from above; also the insertion and removal of the probe tends to mix the grain and distort the air flow, so that none but the first sample withdrawn can be expected to reflect the normal response to ventilation.

Changes in grain moisture were measured in later tests by humidity elements buried in the grain. The Minneapolis-

Honeywell Regulator Company furnished 54 elements to be used for this purpose. A description of the elements and of their use is given at the end of this report. They permitted readings of relative humidity at various locations in the grain mass from time to time as drying proceeded. They were installed as the bins were being filled and were distributed in such a way that the readings could be used to tell whether the drying progressed in a pattern similar to that computed from the pressure readings.

Since one of the purposes of this series of drying tests was to compare pressure operation (the fan forcing air into the tunnel) with suction operation (the fan drawing air out of the tunnel), air flow analyses of the two systems were made. Some results were given in the article entitled "Grain Drying with Unheated Air" (2). It was found in earlier tests that in the pressure bin the areas of poor ventilation were at or near the sidewalls. In the suction bin the areas of poor ventilation were in streaks through the grain. The poorest ventilation in either case is along the flow lines having most curvature and downstream from the curved region.

In the pressure bin the areas with poor ventilation are near the wall where heat penetration from the outside might influence the drying whereas in the suction bin they are in the interior where conditions may be expected to be more nearly adiabatic. For this reason most of the humidity elements were used in the suction bin and were placed in an area where the analysis showed there might be sharp gradients in moisture.

Results of a drying test with corn in October 1953 were discussed in the article "Grain Drying with Unheated Air (2). Figs. 5 and 6 in that report showed the drying time at various locations in the bins as determined from the humidity element readings. In that test the slower locations to dry were about as expected from the pressure analysis but the location of humidity elements did not yield lines of equal drying time.

Two further tests were made in 1954, one with oats and one with corn. In these the elements were confined to the suction bin and were grouped in a relatively small area so that moisture gradients in either direction could be detected. The elements were located as indicated by the dots in Figs. 2b and 3b, four inches apart in one direction and 8 or 10 in apart in the other. In each case, half the elements were in a plane 9 in from the end wall and the other half 18 in. A single plane for all the elements was avoided because if they were too close together their presence might influence the air currents.

Figs. 2a and 3a show the lines of equal pressure, flow lines, and computed lines of equal traverse time. Figs. 2b and 3b show the progress of the drying front as indicated by the humidity element readings. A relative humidity reading of 80 percent was arbitrarily selected as a reference. At points to the right of a given line on the chart, the grain moisture was still above equilibrium with 80 percent humidity; those to the left were below at the reading at the time indicated. The figures on the chart show the drying time. In the corn test, Fig. 3b, the number of hours shown is the total elapsed time from starting the fan. There were some periods when the fan was not running which are not accounted for in the numbers of hours indicated. In both the oat and corn tests it will be seen that the readings of humidity, Figs. 2b and 3b, showed the shape of the drying front to be about like the contours of traverse time in Figs. 2a and 3a. The lines of equal drying time in 2b and 3b are not identical with the lines of equal traverse time, but they have similar advanced and retarded points. For each opening in the wall to admit air to the grain there is an advanced section of the drying front. One reason for the failure of the curves to coincide, aside from experimental error, is that the pressure-measuring points are fixed points, always remaining the same distance from the floor or wall. On the other hand, the humidity elements are buried in the grain and as the grain bulk shrinks they tend to move with the grain so that at any given time it is difficult to know exactly

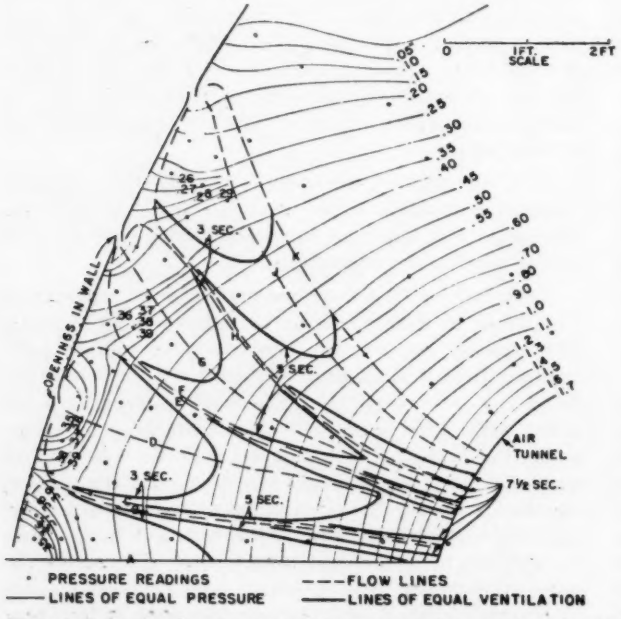
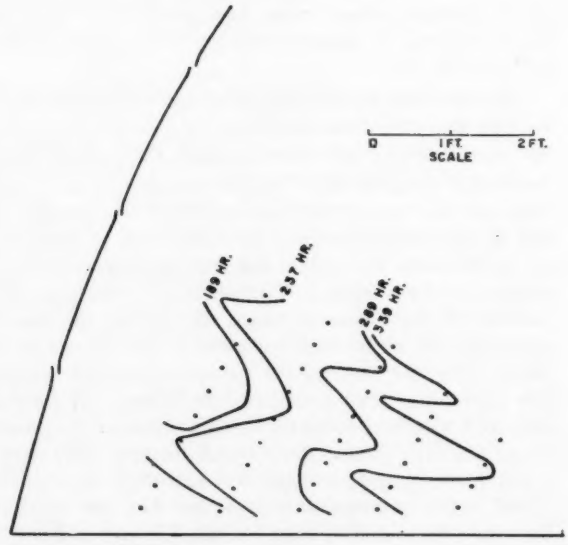


Fig. 3a *(Left)* Air flow in section of corn-drying bin • Fig. 3b *(Right)* Time required to reach 80 percent humidity in corn-drying bin, October 1954



where each element is. In addition the pressure pattern varies as drying progresses so that no one chart can represent exactly the pressure gradients for the whole drying period.

In making the analysis it is necessary to assign a specific relation between air flow and pressure gradient. Shedd's data may be used for this purpose, but it is obvious that variation in density of the grain within the bin gives rise to variations in the relation between air flow and pressure gradient. At present there does not appear to be any way in which this element of inaccuracy can be avoided. The fact that resistance to air flow does change is illustrated by comparison of the total air flow in the pressure and suction bins. In each test the total pressure in both bins has been about equal at the start of drying. In the suction bin this remains approximately constant for most of the drying period. In the pressure bin the total pressure drops off after a few hours of operation. The two fans have identical characteristics so that after the first few hours of drying the pressure bin gets a greater volume of air than the suction bin. This may be accounted for by the fact that a large part of the resistance to flow in each bin is in the region near the tunnel where the velocity is high. In the pressure bin the grain in this region is dried first, it shrinks into a less dense mass, the wet grain above tending to bridge over this region, and the resistance is reduced. In the suction bin the grain in this region dries last so does not loosen until drying is about completed.

In spite of the lack of complete accuracy in locating the flow lines and estimating the traverse time, this appears to be a useful way of finding where drying will be retarded by curved lines of flow and of estimating the relative effectiveness of different systems of air supply.

Estimating a Performance Ratio

On the basis of this air flow analysis it is possible to estimate a performance ratio for the air distribution system by which the time required to dry the poorest ventilated grain can be related to the time that would be required if the air flow lines were all equal. Referring to Figs. 2a and 3a, the line showing a traverse time of 7½ sec is seen to intersect the tunnel for both the corn and oat tests. This indicates that some of the air was discharged from the grain having been enroute less than 7½ sec and some having taken longer. Not shown on the chart but computed by the method described are total traverse times for the air moving along each flow line. These times are tabulated in Table 1. For oats, the ratio of the slowest to the fastest of the flow lines shown is 1.5 and for corn 1.8. This ratio expresses also the ratio of the approximate length of drying times required. Within the limitations of this method of estimation, this ratio shows how much longer the fan has to be operated on account of non-uniformity of air distribution. A truer representation of the increased drying time would perhaps be the ratio of the traverse time for the slowest position, to that for all flow lines in a similar bin to which the air was admitted so that the flow lines were all equal.

The choice of the flow lines on which the computations are made influences the resulting computed traverse time to some degree. It will be seen that if line C, for example, in Fig. 2a had been drawn to follow the wall more closely, the computed traverse time would have been greater. It appears, however, that in spite of the arbitrary choice of flow lines that must be made, this method has some value in estimating the handicap imposed by less than full opening for air intake or outlet.

TABLE 1. TRAVERSE TIME FOR AIR ENTERING THE TUNNEL IN CORN AND OAT TESTS ALONG THE FLOW LINES SHOWN IN FIGS. 2a AND 3a.

	Traverse time (seconds)	
Line	Oats (Fig. 2a)	Corn (Fig. 3a)
A	7.6	5.1
B	10.0	8.9
C	9.2	8.3
D	6.9	5.5
E	9.6	8.4
F	9.4	7.4
G	7.2	5.7
H	9.0	6.9
I	10.6	9.4
J	9.1	6.3
K		6.7
Fastest	6.9	5.1
Slowest	10.6	9.4
Ratio	1.5	1.8

Under the conditions of these tests the grain for the most part has been dried without excessive spoilage. It is obvious that drying could have been completed sooner if the air had been distributed uniformly. The decision as to whether it would be better to provide closer spaced openings rests with the relative cost of providing more opening as compared with the cost of the additional fan capacity and power required when the air distribution is less uniform. Or it might be desirable to balance the increased cost of providing uniform flow against the value of the additional bushel capacity that might be dried with a given fan and motor.

It appears from the analysis of air flow and from the humidity readings that introducing air into grain or exhausting it from grain through openings separated by a solid space causes the drying to take place unevenly but that the pattern of unevenness can be anticipated and evaluated. Presumably the "dead spot" between adjacent ducts in a multiple-duct system results in streaks of slow drying similar to those observed in these tests. It remains to be determined how much this effect is modified by lateral action across the flow lines. No doubt lateral heat flow and diffusion tend to facilitate drying in the places where the air flow is slow, but the tests indicate that these effects may not be depended upon to equalize drying.

The relative humidity elements furnished by the Minneapolis-Honeywell Regulator Co. for trial in this series of tests provided our first opportunity to examine in detail the changes in moisture content that take place during drying in a full-size bin. The elements were designed to measure the relative humidty of the air. The sensitive part of each unit is a gold leaf grid on a plastic plate. The grid is in two parts separated by a narrow gap. The surface of the plate at the gap is covered by a thin layer of hygroscopic salt. When the salt is perfectly dry, its electric resistance is extremely high. If it absorbs moisture, its resistance decreases. A reading of the electric resistance across the gap in the gold leaf

becomes an indication of the moisture content of the salt layer. Since the salt is hygoscopic, its moisture content tends to come to equilibrium with the atmospheric relative humidity. The humidity of the ambient air can be determined by reading the electric resistance after suitable calibration. To get the desired range in humidity, three sensing units are combined to form each composite element. In this manner a range of humidity from 65 to 100 percent can be read. The units are enclosed in a metal case with three screened openings along one side. The case is approximately ½ x 2 x 6 in in size. The elements are sensitive to temperature as well as humidity so it is necessary to read the ambient temperature along with the element resistance in order to get a measure of relative humidity.

In using a reading of relative humidity of air to determine the moisture content of grain, the assumption is made that the grain and air are in equilibrium. During drying they are not in equilibrium so the question arises whether the elements can be used to indicate moisture content of the grain. With an element buried in grain which is being dried by forcing air through it, the readings show the humidity of the air passing the element. If ventilation is stopped, eventually the grain and air may be expected to come to equilibrium so that readings could then be translated to grain moisture content. Some preliminary tests were made in the laboratory, and it was found that after stopping ventilation during drying, the element resistance usually came to equilibrium with the grain moisture in about 1½ hr. It is assumed that readings taken during periods when the fan is running indicate the humidity of the drying air at the location of the element, and that those taken after the fan has been stopped for a suitable period indicate the moisture content of the grain. In using the elements in a bin test, however, it was found that by the time the air humidity at any point had dropped substantially, the grain moisture at that point dropped correspondingly within a short time. For this reason most of the readings were taken without interrupting the fan operation.

Fluctuation in Humidity Readings

There was some fluctuation in humidity readings, particularly when the readings were low. Occasionally, but not very often, a reading below 80 percent humidity would be followed by a later reading at the same point which was above 80. At humidities lower than 80 percent such reversal occurred more frequently. In view of the fact that, when the air humidity dropped to 80 percent, the grain moisture soon dropped correspondingly, and since the fluctuation made it difficult to assign the time when the humidity reached lower levels, 80 percent was arbitrarily chosen as the humidity level to be used as a gauge for drying time. Accordingly, Figs. 2b and 3b are based on the time required to reach 80 percent humidity.

At very high relative humidities the element readings when translated to humidity by the calibration data sometimes indicated more than 100 percent humidity. This indicates that in the upper end of the range the determinations of humidity were not accurate. For this purpose this is not serious, since it is not as important to know the exact humidity as it is to know when the grain is dry. After one year's use the elements were returned to the factory for recalibration. The changes in calibration were almost all in the same direction; that is, the resistance of each element after one year's use was higher for a given humidity than at the first calibration. The average change in calibration was not more than 2 percent for each of 37 elements. Of the remaining 17, the average change was about 3 to 4 percent on all but one. One element showed a change in calibration of 7 to 9 percent and in the opposite direction to the changes taken by the others. These variations are not explained. For the purpose of these grain-drying tests these variations are not serious. In the tests it was found that the reading remained high until the drying zone reached the element and then the reading dropped within a few hours followed by fluctuations up and down, presumably in response to atmospheric changes. A typical set of readings is shown in Fig. 4. The data of Fig. 4 are from the 1954 oat test and represent the readings of the elements in the second row from the left as shown by dots in Fig. 2b. Element 12 is at the bottom and 20 at the top. This figure shows that at any given point the moisture drops quickly after drying starts at that point. Obviously an error in humidity reading even of several percent would not affect the shape of these curves very much nor would it change the observed time of drying very much.

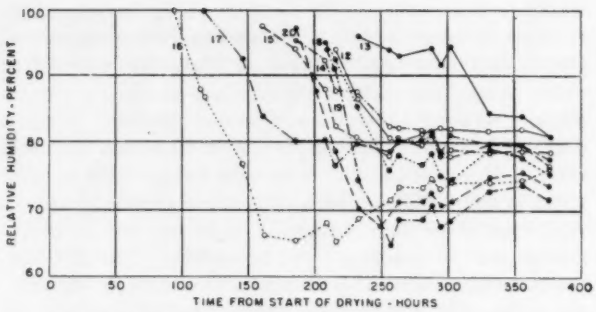


Fig. 4 Humidity versus time at various points in oat bin

The humidity elements have proved to be very useful in detecting moisture gradients in drying grain.

BIBLIOGRAPHY

1 Hukill, W. V. and C. K. Shedd. Ventilation of oats in 16x20-ft quonset buildings, July—August 1953 at Ames, Iowa. An unpublished report.

2 Hukill, W. V. Grain drying with unheated air, AGRICULTURAL ENGINEERING, vol. 35, pp. 393-395, 405, June 1954.

3 Shedd, C. K. Resistance of grains and seeds to air flow. AGRICULTURAL ENGINEERING, vol. 34, pp. 616-619, September 1953.

Mechanical Feeding of Livestock

(Continued from page 461)

BIBLIOGRAPHY

1 Kelly, C. F., T. E. Bond, and N. R. Ittner: Engineering design of a livestock physical plant, AGRICULTURAL ENGINEERING, 34 (9): 601-607, 1953.

2 Meyer, J. H. and G. Lofgreen: Unpublished data, University of California, Davis, 1954.

3 Kleis, R. W.: Moving feed from storage to feeding point. AGRICULTURAL ENGINEERING 35(9):655-656, 660, 1954.

4 Terry, C. W.: Vacuum unloader for handling forage. AGRICULTURAL ENGINEERING 30(3):141-142, 1949.

5 Esmay, Merle L. and Donald B. Brooker: Horizontal self-feeding silos, AGRICULTURAL ENGINEERING 34(9):620-623, 630, 1953.

Sediment Production in Small Watersheds

Russell Woodburn
Member ASAE

THE hill portion of the Yazoo watershed in Mississippi has suffered great damage through stream and valley sedimentation for a long period. The soils are generally old Gulf deposits largely unconsolidated and in some cases capped with loessial material ranging in thickness from a few inches to many feet.

Vast areas of the upland have undergone serious erosion which has usually proceeded to the point of large gullies of intense activity. The sandy subsoil material from the gullies has filled upstream channels and has caused extensive valley deposits. There has been direct crop damage due to sand deposits over the valley floor and the indirect damage due to flooding from even small runoff since many of the channels are no longer effective.

The flood prevention program of the U.S. Department of Agriculture in the Yazoo basin involves in addition to other activities a widespread attack on the sediment-producing areas either through vegetative or mechanical means or both. In planning reservoirs for water detention or sediment retention, sediment-production rates for the watersheds are critically needed for design.

In the case of drop-inlet structures, the reservoir volume below the elevation of the top of the riser pipe is ordinarily dedicated to ultimate use as sediment storage. Reasonable design necessitates that a fair estimate should be made of rate of sediment yield and sediment-storage volume needed for any specific design time. It is assumed that the sediment-production rate of the watershed will be substantially reduced by gully treatment and land-use conversions before the sediment-storage volume is entirely filled.

Sedimentation research in this area has been concerned with estimating erosion rates from various land and cover complexes and then attempting to answer the question—of the amount of erosion material produced from various elements of the watershed, how much ultimately finds its way to any particular point downstream under consideration?

In an area as extensive as the 6,500 square miles of the Upper Yazoo, there are obviously many more aspects of sedimentation which are of interest, such as channel stability below structures, design of stable channels in unstable sedimentary materials, channel transport rates for sediment and numerous other problems in sedimentation and hydrology.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Soil and Water Division, and reporting research cooperative with the Mississippi Agricultural Experiment Station.

The author—RUSSELL WOODBURN—is hydraulic engineer, watershed hydrology section, Soil and Water Conservation Research Branch (ARS), U.S. Department of Agriculture, stationed at State College, Miss.

Acknowledgment: The author acknowledges the valuable assistance of J. B. Burford, hydraulic engineer, formerly attached to the project; John Kozachyn, soil conservationist, who recently joined the project; John Roehl, geologist, Soil Conservation Service (Spartanburg, S. C.); W. L. Heard, assistant state conservationist, Soil Conservation Service, and members of his staff (New Albany, Miss.), and Travis King, work-unit conservationist, Soil Conservation Service (Oxford, Miss.)

*Numbers in parentheses refer to the appended bibliography.

Discussion of sediment-yield studies in the Yazoo (Mississippi) watershed preliminary to a widespread attack on this sediment-producing area through vegetative or mechanical means or both

It is the purpose of this paper to discuss sediment-yield studies of recent years, 1949 to 1954, on small gullied areas, partly gullied areas up to 500 acres and one watershed of 12 square miles. Mention will also be made of channel degradation investigations.

Sediment Yields From Small All-Gullied Areas of 2 or 3 Acres

Sediment yield studies in the Yazoo watershed were first made on gullies since such areas were considered the most critical from the standpoint of sediment source. In 1936 the Sedimentation Division of the Soil Conservation Service selected a typical gully of moderate size and installed several hundred monuments which were concrete-filled auger holes. As the gully walls eroded back, the concrete-filled holes became projecting plugs which were measured in 1937 and 1939. The final measurement was made in 1949.

This project was reported in detail by Woodburn (5)* with the conclusion that such gullies produce about 2 in per year (vertical measure) of erosion materials or ⅛ acre-foot per acre per year of active gully surface. Subsequent studies of sediment accumulation in small debris basins or "sand traps" substantially verified the 2 in per year gully erosion rate. While the 2 in per year gully erosion rate was helpful for design of gully structures or small dams controlling only a few acres, further information was necessary when dams were designed for larger areas including various soil and cover complexes as well as gullies.

Sediment Yields From Partly Gullied Watersheds of 5 to 500 Acres

In 1951 the Soil Conservation Service initiated a study of small reservoirs in North Mississippi(6) to evaluate the effects of watershed characteristics on sediment production.

Sedimentation surveys were made of 23 small reservoirs with drainage areas of 7 to 600 acres. Following the method presented by Gottschalk(2), reservoir sediment was related to various watershed characteristics, which with the exception of gross erosion could be measured fairly well. Unfortunately there were no reservoirs in the larger drainage areas studied which had a high percentage of cultivated or gullied land. The larger drainage areas were generally in the fairly low erosion classification of pasture and woods.

In general the watershed factors did not correlate as well as expected with measured sediment in the reservoirs probably on account of our inability to accurately estimate gross erosion rate. However, the best possible relationship was developed from the study and is being used in view of the pressing field need for sediment design criteria.

A logarithmic relationship was derived from the data as follows:

$$S = \frac{W^{.8957}\ T^{.6573}\ E^{.8573}\ C^{.3423}}{2.578}$$

in which S=sediment in tons

W=watershed area, acres

T=age of reservoir, years

E=gross erosion rate, tons per acre per year (150 tons per acre-inch, average weight of upland soil)

C=capacity watershed ratio, acre-feet per square mile.

Gully erosion and sheet erosion were computed separately in determining gross erosion rate for the watersheds. Gully erosion could be calculated fairly well but sheet erosion was difficult. In the absence of long period erosion plot data for the area, the applicable regional soil decline rate of 0.413 in per year for cultivated land (10 percent slope 72 ft long) was used, corrected upward to 0.473 for local rainfall intensity after Musgrave(4). Correction was made for length and degree of slope also by the method outlined by Musgrave (4). Pasture was estimated as 20, 8 and 0.5 percent of cultivated land for poor, medium and good cover. Woods erosion was estimated as 5.0 and 0.5 percent of the cultivated rate for poor cover and good cover, respectively.

It is felt that the formula although subject to some shortcomings gives reasonable estimates and precludes serious overdesign or underdesign of structures in the range up to 600 or 700 acres. A typical situation where T= 10 years, E=60 tons per acre per year, C=150 acre-feet per square mile for watershed areas (W) of 100 acres, 300 acres, 600 acres and 1000 acres would result in sediment yield estimates of 20,450 tons, 54,400 tons, 101,300 tons and 160,000 tons. This would represent 34.1, 30.2, 28.2, and 26.6 percent, respectively, of the total gross erosion material as deposited or recovered in the proposed reservoirs. Several reservoirs constructed in 1953 were selected for detailed study and range systems were installed for future study of sediment volume and distribution. Their drainage areas average about 300 acres. Periodic resurveys are planned.

Fig. 1 Layout of 1937 ranges in East and West Goose Valleys above range G-7 (Lafayette Co., Miss.)

Sediment Yields From Larger Watersheds

(A) Estimates by Means of Channel Transport Capacity Calculations. Studies were made of the possibility of the application of the Einstein sand transport equation (1) to the problem. When such a calculation is made for a reach of channel above the site of a proposed structure, a determination must be made of channel slope, channel geometry and size distribution of the bed sand. If the channel is essentially in equilibrium, then the computed transport capacity of the channel for sand should be roughly equal to the amount being carried.

A computation of transport capacity, carried through an annual flow-duration curve, if available, should therefore give some indication of the amount of sand moved past the point annually. Calculation of the amount of sediment passing a given point in a channel applies only to the bed material load, that is, the sand of the sizes represented by the bed. There is little opportunity to estimate the amount of "fines" that is silt and clay that would pass the same point. The fine material or wash load is a function of the watershed and of the character of rainfall. It would have little relationship to the channel characteristics as the channel flow would rarely be loaded to capacity with wash load.

It is believed that channel estimates of watershed yield of wash load would require suspended load sampling. This is a difficult matter on the smaller stream where the flow is ephemeral in nature and the wash load varies widely.

Calculations were made of sand transport capacity of several channels in the Big Sand Creek system in Carroll County, Mississippi. The results of sand transport computations are shown in Table 1. *Annual* sand transport shown in the table is directly related to amount and distribution of annual flow. There were no flow duration data available for the Big Sand Creek watershed so a synthetic flow duration curve was derived based upon about 18 in of annual runoff. This curve was scaled down for each tributary on the basis of the same annual runoff but weighted for higher rate short period flow.

The computed sand yield from the watersheds in cubic yards per square mile appeared fairly reasonable and somewhat in keeping with the known amount of gullied land in the watershed, with the exception of Upper Big Sand Creek and Whitehead Creek. Results from these two channels are difficult to reconcile with the others. The sand fraction of the erosion on these two is known to be less than on the others although the results obtained are probably far too low. This method of estimating bed material sediment yield from smaller watersheds appears to have some possibility but serious inconsistencies are still present.

Smaller channels present the greatest problem in such calculations on account of the necessity for estimating bank

(Photos by courtesy of U.S. Soil Conservation Service)

Fig. 2 *(Left)* Extensive gully systems of this type in the headwaters of Goose Creek Watershed provide vast quantities of sand. Erosion takes place at an average annual rate of about 2 in per year or over 300 tons per acre of exposed surface per year • Fig. 3 *(Right)* A section of West Goose Valley between State Highway 6 and the Old Batesville Road. The channel is filled with sand and the bottom land has been damaged with sand overwash.

friction to add to the computed bed friction. As the channels become wider, there is less effect of bank friction on flow and a point is reached where bed roughness largely governs.

An opportunity was presented to roughly check the results for the Big Sand Creek main stem at Valley Hill, Miss., where the creek enters upon the Yazoo Delta.

TABLE 1. COMPUTED SAND TRANSPORT CAPACITY OF BIG SAND CREEK AND SOME TRIBUTARIES

	Drainage area sq mi	Computed sand transport cap., cu yd/yr	Cu yd/sq mi of drainage area/year	Equivalent depth over drainage area, in	Gullied land required to produce this amount, acres/sq mi
Big Sand Creek tributaries					
Magic Creek	9.57	48751	5094	.0592	18.9
Thompson Creek	14.64	38579	2635	.0306	9.8
Beasley Creek	12.84	34668	2700	.0313	10.0
Little Sand Creek	14.80	17420	1177	.0137	4.37
West branch of Little Sand Creek	1.85	6093	3290	.0382	12.2
Little Rock Creek	4.01	12610	3145	.0365	11.7
Upper Big Sand Creek	25.11	8394	334	.0039	1.24
Whitehead Creek*	4.32	307.3	71	.000825	.264
Big Sand Main Stem, Valley Hill	113.96	410143	3599	.0418	13.38

*A part of Upper Big Sand Creek.

Estimates made by the U.S. Army Corps of Engineers of the rate of build-up of the alluvial fan or cone along Big Sand Creek at the edge of the Delta below Valley Hill are in the range of 1,000,000 cu yd per year. Borings on the cone revealed that the deposits were approximately 45 percent sand. 450,000 cu yd of sand would, therefore, be of the same order of magnitude as our calculation of sand transport of 410,143 cu yd.

(B) Estimates by Means of Measurements of a Plugged Valley Below a 12-Square Mile Drainage Area. Recent field studies of East Goose Creek and West Goose Creek have contributed some further information on sedimentation rates and other related phenomena in a 7,840-acre watershed.

In 1937 Happ and Rittenhouse (3) established ranges across the valleys of several streams in Lafayette County, Miss., including East and West Goose Creeks.

They made an estimate of the sediment yield of the watersheds by means of boring through the sediment on these ranges. It was assumed that the modern valley deposits indicated by the borings represented about 100 years accumulation. It was pointed out that the validity of such an estimate would be influenced by the certainty with which the boring could determine the bottom of the modern sediments as well as the proper period of time to which to charge the accumulation. The amount of fine material carried entirely through the measured valley would also be important although it was apparently small in this case, being estimated as 8.1 percent of valley fill.

In the fall of 1954, an attempt was made to relocate the ranges used by Happ and Rittenhouse in 1936-37 in East Goose Creek and West Goose Creek. These efforts met with considerable success as virtually all of the range markers were recovered. The ranges were surveyed for the determination of change in cross-section area in the past 17½ years (Fig. 1).

It is realized that a high degree of accuracy cannot attend the computation of valley fill during the period based on ranges (or cross sections) as far apart as were used. One additional range was provided between W.G. 3 and W.G. 4 by using the ground line profile of State Highway 6 which was constructed in 1938 and surveyed in 1937. This cross-valley profile was transposed 60 ft south to the present south right-of-way fence which was used for a 1954 range. It is believed that a fair estimate may be made of the sediment delivered to the valley from the watershed on the basis of the enlarged range system used.

In 1936 a plug existed in the vicinity of range G-7 (upward into both east and west forks). G-7 is located just below the confluence of East and West Goose Creeks. It is therefore likely that only a small portion of the sediment delivered to the valley was transported below this point. The valley floor above the range might be considered somewhat as a reservoir at this point.

Valley aggradation during the 17½-year period, 1937 to 1954, was found from our 1954 surveys in the amount of 640 acre-feet from the 12.25-square-mile watershed. Happ

and Rittenhouse (3) reported 3,698 acre-feet of "modern" fill above range G-7. Modern fill was considered to have been deposited during the 100-year period, 1837 to 1937. The average yearly rate is virtually the same as that from 1937 to 1954. This is not surprising as there is a long history of swamping and poor drainage in these valleys, particularly in the upper reaches above range G-7.

The channel system was probably inadequate to handle the increased sand load brought about by heavy upland erosion quite early in the 100-year period. New channels were constructed in 1920 by a drainage district but according to reports they had ceased to function properly by 1927.

It is therefore likely that the results from the 100-year period study reflect fairly well the sediment delivered to the major valleys. From this point of view, the yearly rates of accumulation would be expected to be of about the same order as from 1937 to 1954, when a valley plug was known to exist.

It is of interest to speculate upon the amount of gross erosion over the entire watershed above range G-7 in the period 1937 to 1954 contributing to the 640 acre-feet of valley fill. Gross erosion as used in this sense may be thought of as local soil movement of the type measured at the end of a small runoff plot or in a debris basin immediately below a gully area of an acre or two. It cannot be measured on a watershed of any great size but can only be estimated and would always be greater than sediment as measured in main valley reservoirs or deposits. As a watershed increases in size, the percentage of gross erosion material recovered as sediment in a plugged valley or in a reservoir would be expected to decrease.

An estimate of gross erosion for the watershed above G-7 during the 17½-year period, 1937 to 1954, was made as follows:

In the course of the design by Soil Conservation Service field engineers of 9 dams with an aggregate drainage area of 1729 acres in the headwater section of the watershed, a detailed examination was made of the watersheds above the dams from the standpoint of erosion material produced. The same gully erosion rates and sheet erosion rates used in the reservoir study previously described were used. The average weighted gully erosion rate for the 1729 acres was calculated as 0.0211 acre-feet per acre per year and the average weighted sheet erosion rate as 0.00616 acre-feet per acre per year. The remaining 6111 acres of the 7840-acre watershed although not studied in detail was know to be less gullied and to have more cultivated land so it was estimated as 0.0105 acre-feet per acre per year for gullies and the sheet erosion rate as 0.01232 acre-feet per acre per year. This results in an average gross erosion rate of 0.0238 acre-feet per acre per year or 0.286 acre-inch per acre per year over the entire area. Based on 150 tons per acre-inch, this means 42.9 tons per acre per year average gross erosion rate over the 7840-acre watershed.

At this rate, the watershed would have suffered 3270 acre-feet gross erosion or soil movement. With 640 acre-feet measured in the valley, we have recovered as valley sediment 19.6 percent of the total watershed erosion. Stated in another way, of the gross erosion rate over the watershed of 0.286 in per year the sediment production rate as measured in the valley was 0.0561 in per year.

Considering the period 1837 to 1937 and using the same gully erosion rates that were estimated for 1937 to 1954, there would have been 10,735 acre-feet sand erosion over the watershed. The valley fill accounted for 1,248 acre-feet of sand (3), or 11.63 percent of that calculated as produced on the watershed (gully erosion).

Silt measured in the valley fill (3) was 2,449 acre-feet, or 28.78 percent of the calculated silt erosion material (sheet erosion) of 8,510 acre-feet.

It is realized that the size distribution of erosion materials is oversimplified to refer to gully erosion as sand and sheet erosion as silt and clay as each erosion class may contain some of both. There is little opportunity, however, to set up any more precise measure so the predominant size is used.

When the best available information was used to estimate gully erosion (sand) and sheet erosion (fines), it may be seen that measured valley fill accounted for only 11.63 and 28.78 percent, respectively, of the gross erosion material. If the gross erosion rates were reduced by half, there would still remain a wide gap between watershed gross erosion and valley fill or sediment in this case. This emphasizes the fact that in estimating sediment production from an area of this size a liberal reducing factor is necessary for application to the gross erosion estimate.

The reservoir study formula, although not designed for areas of this size, was used as a matter of interest to estimate sediment from the 12-square-mile watershed. With the assumption that a reservoir was built above G-7 with a capacity-watershed ratio of 150 acre-feet per square mile, the formula was used to estimate the 17½-year sediment accumulation. This resulted in 890,000 tons or 15.10 percent of the watershed gross erosion of 5,890,000 tons, or 3,270 acre-feet.

In addition to the reservoir formula now in use another formula (without the factor C) was derived from the 23 reservoir study. It is

$$S = 2.130\ W^{0.9151}\ T^{0.7329}\ E^{0.8303} \qquad \text{(reference 6)}$$

When this formula was used for the 7,840-acre watershed for a 17.5-year period, $S = 1{,}435{,}000$ tons. This estimate represents 24.3 percent of the gross erosion from the watershed. The formula without C has not been recommended for field use; however, it may be seen that the amount of valley fill in lower Goose Creek, determined by field surveys, was actually of the order of magnitude represented by either formula.

Channel Degradation Below Dams

In East Goose Creek valley, channel ranges were established in 1951 in order to check degradation expected following the construction of several dams in the south end of the watershed planned for 1952-53. The ranges extended through the reach from the Old Batesville Road for 4200 ft downstream to the deposition area (see map) and from the road upstream for 7000 ft to East Goose dam No. 2.

A resurvey in 1952 before the dams were in service showed little channel change in the reach from the Old Batesville Road downstream for 4200 ft to the point where the channel faded out into the natural deposition area. The lower channel system appeared to be essentially in equili-

(Continued on page 473)

Irrigation of Pastures

Gilbert Levine, W. K. Kennedy and H. E. Gray
Assoc. Member ASAE Member ASAE

Results of a study of a range of water applications to pasture plots and the effect of these application levels on a range of nitrogen-application levels on the growing crop

INCREASING irrigation of pastures in northeastern United States has stimulated the need for factual information concerning pasture response to irrigation, the influence of irrigation on pasture response to other cultural practices, and practical methods of determining when and how much to irrigate. Yield increases due to irrigation have been obtained in many areas, but in general the only comparison has been between supplementary water application and natural rainfall. There have been few attempts to evaluate the effect of irrigation upon other cultural practices.

In 1951 an experimental program was initiated by the departments of agricultural engineering and agronomy at Cornell University. Two years were spent in evolving suitable experimental techniques and conducting preliminary experiments. The final experiment has been conducted for the past two years. This experiment was set up to study a range of water applications, as well as the effect of these levels upon the use of nitrogen by the growing crop. A range of nitrogen levels was included. Information concerning this interaction was of considerable interest, since it has been thought that the combination of water and fertilizer would give large yield increases. As an adjunct to the experimental comparisons, an evaluation of the consumptive-use method of scheduling irrigation was included.

Experimental Design and Procedure

Design. The desire for different levels of irrigation and nitrogen fertilization, coupled with the use of a rotary-sprinkler irrigation system, imposed certain limitations upon the experimental design. The irrigation plots were located parallel to the sprinkler line; these were split at right angles by the fertilizer plots. Fig. 1 illustrates the plot layout.

The general experimental design was one of a randomized split-plot type. The randomized fertilizer plots were split at right angles by the irrigation plots. Prior to the experiment, a study of the irrigation pattern under the prevailing wind conditions indicated where the irrigation plots should be located to give the desired application. This method of location prevented the randomization of the irrigation treatments, which necessitated a larger yield difference to be statistically significant. This was not a serious limitation, however, since pasture yield increases must be relatively large for irrigation to be of economic value. Since the fertility plots were randomized, the evaluation of the irrigation-fertilization interaction was not greatly impaired.

After the first harvest was removed in June 1953, the experiment was initiated on a three-year-old, uniform stand of alfalfa and brome grass. The soil was a well-drained gravelly loam with a pH of 6.4 to 6.7. In 1953 and 1954, the entire experimental area was top-dressed with 0-20-20 fertilizer at the rate of 500 lb per acre after the first harvest was removed. At the same time, the first increment of nitrogen fertilizer was applied to the proper plots. In 1953, one-fourth of the nitrogen was applied after each of the first four cuttings were removed. Twenty-five pounds of actual nitrogen was applied at one time for the plots receiving 100 lb of nitrogen per acre per year, and 50 lb of nitrogen was applied at a time to the plots receiving 200 lb of nitrogen per acre per year. In 1954, one-third of the total nitrogen was applied after each of the first three cuttings. The yearly rate was the same as in 1953, 100 and 200 lb per acre per year. For all applications, ammonium nitrate was the source of nitrogen. Four water levels were studied, including water application to bring the soil moisture to field capacity after being depleted (1 in in 1953; 1½ in in 1954) as determined by estimated consumptive use (I_3); 0.8 of I_3 irrigation applied at the same time as I_3 (I_2); 0.6 of I_3 irrigation applied at the same time as I_3 (I_1); natural rainfall (I_0).

Schedule of Irrigation. Irrigation was scheduled on the basis of estimated soil moisture depletion which was calculated by subtracting consumptive use from precipitation: Consumptive-use was considered to be 80 percent of the evaporation from a free water surface. In 1953, the average evaporation for a 20-year period at the Ithaca weather station was used. In 1954, the evaporation measured at the experimental site was the basis for the estimate.

When the soil moisture of the plots closest to the sprinkler line (I_3) was depleted the desired amount, all the plots were irrigated. Sufficient water was added to bring the I_3 plots back to field capacity. The application equalled the calculated consumptive-use plus an additional quantity to compensate for field irrigation losses. Field irrigation efficieny was considered to be 80 percent. Soil moisture content was followed by the use of plaster-of-paris blocks. Two complete replications were studied, with blocks set at 6 in,

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors—GILBERT LEVINE, W. K. KENNEDY and H. E. GRAY—are, respectively, assistant professor of agricultural engineering, professor of agronomy, and associate professor of agricultural engineering, Cornell University.

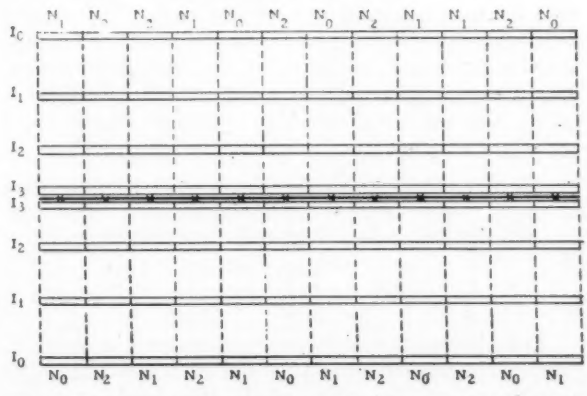


Fig. 1 Plot layout for a pasture irrigation experiment in New York, 1953-54

1, 2, and 3 ft. A calibration curve correlating meter reading and percent moisture was determined in the laboratory.

Harvesting. Individual plots 40 in by 20 ft were harvested, with both green and dry weights determined.

Results

Irrigation. In 1953, the first cutting was removed by the farmer before the experiment was initiated. During the remainder of the season nine irrigations were applied giving total water application as follows: I_0=12.84 in, I_1=19.91 in, I_2=21.39 in, I_3=23.25 in.

Irrigation increased the yield of forage from the third and fourth cuttings but had little effect on the second cutting harvested July 2 or on the fifth cutting harvested October 9. The seasonal increase due to irrigation was 680 lb of dry matter per acre (Table 1).

TABLE 1. DRY MATTER YIELD OF ALFALFA AND BROME GRASS MIXTURE IRRIGATED WITH DIFFERENT LEVELS OF WATER

	1953					1954				
	2nd	3rd	4th	5th	Total	1st	2nd	3rd	4th	Total
Date cut	7/2	7/30	8/28	10/9		6/3	7/29	9/10	10/19	
No irrigation	960	200	490	140	1790	3070	310	440	260	4080
Low	1010	340	920	160	2440	2500	580	750	350	4180
Medium	930	340	1090	160	2520	2470	550	920	330	4270
High	990	340	940	190	2460	2600	460	910	320	4300
Significant for irrigation	n.s.	0.01	0.01	n.s.	0.01	0.01	0.01	0.01	n.s.	n.s.

Irrigation favored the growth of brome grass more than it did the growth of alfalfa. Forage from the third and fourth cuttings was almost pure alfalfa from the plots receiving no irrigation and no nitrogen, while the forage from plots receiving irrigation but no nitrogen contained 20 to 25 percent grass. The yield and botanical composition of forage were the same from all irrigated plots.

In 1954, supplemental water was applied four times during the growing season, giving total water applications as follows: I_0=15.18 in, I_1=19.91 in, I_2=21.71 in, *and* I_3=22.61 in.

The first cutting was harvested before the first irrigation was applied and the yield of forage from the plots, which had not been irrigated the previous summer, was 550 lb of dry matter per acre more than from the plots which had been irrigated. In the second and third cuttings, irrigation increased the yield of forage especially the brome grass. While the increase in yield from irrigation during the remainder of summer was slightly greater than the decrease in yield of the first cutting, the 1954 seasonal yields of irrigated and non-irrigated plots were not significantly different.

As a result of two successive seasons of irrigation, the yield of the alfalfa and brome grass mixture was increased by a total of 850 lb of dry matter per acre. Thus the average annual increase was 425 lb of dry matter per acre.

While irrigation resulted in a relatively small increase in yield of dry matter, it increased the succulence and green matter yield of forage. For example, in 1953 the average yields of green matter were 5580 and 9490 lb per acre for the non-irrigated and heavily irrigated treatments, respectively. In 1954, including the preirrigation cutting which was one ton heavier on the non-irrigated plots, the respective yields were 15, 150 and 17,030 lb per acre. This increase in succulence made it appear that irrigation was causing a much greater increase in yield than the dry matter measurements revealed, and emphasized the danger of using visual observations to estimate yield differences between irrigated and non-irrigated forage.

Nitrogen Fertilization. With the exception of the third cutting 1953, nitrogen fertilizer increased the yield of forage for all cuttings both years (Table 2). The seasonal increases in dry matter for 100 lb of nitrogen per acre were 760 and 1170 lb of dry matter per acre in 1953 and 1954, respectively. The increases for 200 lb of nitrogen per acre were 1200 and 2430 lb of dry matter per acre. These increases were almost entirely due to the better growth of brome grass.

TABLE 2. DRY MATTER YIELD OF ALFALFA AND BROME GRASS MIXTURE FERTILIZED WITH DIFFERENT LEVELS OF NITROGEN

	1953 cuts					1954 cuts				
	2nd	3rd	4th	5th	Total	1st	2nd	3rd	4th	Total
No nitrogen	710	300	550	90	1650	2340	360	250	60	3010
100 lb N/A	1010	310	930	170	2410	2630	480	720	330	4180
200 lb N/A	1200	310	1110	240	2850	3010	590	1290	570	5440
Level of sig.	0.01	n.s.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Except for the third cutting of 1954, no nitrogen x irrigation interaction was observed. For this cutting, the nitrogen-fertilized plots responded better to irrigation than the non-irrigated plots, but the differential response was small and no interaction was found for the total seasonal yields.

Irrigation Scheduling. The results of scheduling irrigation on the basis of evaporation information will be presented and discussed in a succeeding article. This will be combined with an amplification of the soil moisture studies.

Discussion

The fact that the yields among the three irrigation levels were not different requires some explanation. Though the actual amount of water received by the heaviest (I_3) and the lightest (I_1) irrigation plots differed by approximately 3½ in in 1953 and 2½ in in 1954, the actual consumptive-use difference was only 2.19 in in 1953 and 0.5 in in 1954 (Table 3). This lack of difference can be explained by the differential efficiency with which natural rainfall was used. Each summer heavy rainfall occurred within a few days after the plots were irrigated. The soil of plots which received heavy amounts of supplemental moisture was near field capacity and very little of the rainfall could be held, while the soil on the low irrigated plots had appreciable moisture storage capacity. Thus rainfall replenished the soil moisture deficit on the low irrigated plots and brought the soil of the three levels of irrigation to a common base. This occurred one or more times during each summer so that a differential in soil moisture could not be maintained throughout the season. It would appear that the moisture level maintained in the I_1 plots was sufficiently high to remove moisture as a factor limiting plant growth.

TABLE 3. CONSUMPTIVE USE OF WATER BY THE IRRIGATED PLOTS

Irrigation level	Consumptive use of water, inches	
	1953	1954
I_3	17.85	19.03
I_2	16.43	19.15
I_1	15.66	18.53

The adverse effect of the previous summer's irrigation on yields of the first cutting in 1954 is difficult to explain. The combination of irrigation which stimulated vegetative growth in 1953 and frequent clipping, may have seriously

depleted the root reserves of both alfalfa and brome grass. Thus the plants went into the winter in a weakened condition and growth the following spring was reduced. While this appears to be the most logical hypothesis for explaining why irrigating the previous summer reduced the first cutting yields in 1954, another possibility might be that the supplemental water caused excessive leaching of nutrients such as potassium from the soil profile. Since low levels of irrigation reduced yields as much as high levels of irrigation, the low yield of first cutting in 1954 was probably not due to leaching.

By delaying the application of nitrogen fertilizer until after the spring flush, the yield of aftermath was increased materially. One hundred pounds of actual nitrogen per acre increased summer yields of forage as much as irrigation and at considerably lower cost. Furthermore, nitrogen applied in the summer of 1953 increased the yield of first cutting in 1954, rather than decrease it as did irrigation. Much of the nitrogen applied in the summer of 1953 was not utilized that season but was available for stimulating early spring growth in 1954.

Although it is frequently suggested that high rates of fertilization are necessary to obtain a response to irrigation, the lack of an irrigation x nitrogen fertilizer interaction indicated that low nitrogen fertility was not preventing a response to irrigation. In fact, the *percentage* response to nitrogen was greater for the non-irrigated plots than for the irrigated plots. This indicates that nitrogen fertilization resulted in more efficient use of the natural rainfall by increasing root growth, thereby giving a larger soil zone from which to draw water. Futhermore, the *percentage* response to irrigation was greater for the no-nitrogen plots than for the nitrogen plots. At the lower moisture level, the addition of nitrogen apparently decreased the transpiration ratio, which resulted in the more efficient use of the available water. The results of this experiment would suggest the desirability of using fertilizer to its practical limit for increasing forage yields before initiating an irrigation program which is frequently more expensive.

Summary

A method for using rotary sprinklers in small plot irrigation experiments was tested and found to be very satisfactory for forage crops. In addition to natural rainfall, three levels of supplemental irrigation were applied to a uniform stand of alfalfa and brome grass. The soil was a gravelly loam which was liberally fertilized with phosphorous and potash. Three nitrogen fertility treatments were studied under each of the four moisture levels.

Yield increases were the same for the three levels of supplemental irrigation, and averaged 680 and 720 lb of dry matter per acre during the summer months of 1953 and 1954, respectively. However, the spring production of 1954 was reduced by 550 lb of dry matter per acre when the plots had been irrigated the previous summer. Thus, irrigation showed a net yield increase of only 850 lb of dry matter per acre over a two-year period.

Nitrogen fertilizer increased yields 760 and 1200 lb of dry matter per acre in 1953 and 1170 and 2430 lb of dry matter per acre in 1954 for 100 and 200 lb of actual nitrogen per acre, respectively. An irrigation x nitrogen fertilizer interaction was observed for only one cutting.

Sediment in Small Watersheds

(Continued from page 470)

brium at the time. The picture was changed, however, in 1954 with the dams in service in the headwater area. A high-intensity rain of about 4 in occurred on May 27. A survey in August, 1954, indicated channel degradation of 7700 cu yd from the deposition area upstream for approximately 2400 ft.

The channel system in such a watershed of heavy sediment production seems to be a rather sensitive indicator of the sediment production and transport from the watershed. When large areas of sand-producing gullies are cut off by dams, degradation at some point is expected. It may be rather difficult to predict just when and where this will occur. Generally, there has been less cutting immediately below the dams than expected since the flow from the dams is a controlled flow due to reservoir storage and also because stream flow has been low for the past two dry years.

Channel cleanout may be expected at a point further down where uncontrolled tributaries of low sediment production enter their flow with an excess of water over sediment.

The matter assumes considerable economic importance as landowners become interested in the construction of new drainage ditches in the sanded valleys after the sand is cut off by dams above. Has enough sand been excluded to cause channels excavated in the unstable valley materials to degrade excessively or has the amount of sand cut off been too little to alter the previous trend toward channel filling? These questions will be considered in the course of future studies.

BIBLIOGRAPHY

1 Einstein, Hans Albert. The bed-load function for sediment transportation in open channel flows, USDA Technical Bulletin 1026, September, 1950.

2 Gottschalk, L. C. and Gunnar M. Brune. Sediment design criteria for the Missouri basin loess hills, SCS TP97, Milwaukee Office, October 1950.

3 Happ, S. C., Gordon Rittenhouse and G. C. Dobson. Some principles of accelerated stream and valley sedimentation, USDA Technical Bulletin 695, May, 1940.

4 Musgrave, G. W. The quantitive evaluation of factors in water erosion, a first approximation, *Journal of Soil and Water Conservation*, 2(3):133-138, 170 July, 1947.

5 Woodburn, Russell. Science studies a gully, *Soil Conservation*, vol. XV, no. 1, August, 1949.

6 Unpublished report of a reservoir sedimentation study by Russell Woodburn, Soil Conservation Service, Research; John W. Roehl, Soil Conservation Service, Water Conservation Division, former Regional Office, Spartanburg, S. C.; and L. C. Gottschalk, Soil Conservation Service, Washington, D. C.

On Ingenuity

THERE is no short cut to ingenuity. It has either grown through the formative years, or a man has let it wither and perhaps even die. . . . Whether encouraged or not, ingenuity is one of our critical national resources. It is the ingredient that transforms engineering into a creative function—that advances technology into unexplored areas—that opens new doors for the industrial designer.

Basically, ingenuity is an attitude of mind, an angle of approach to new problems. It can be cultivated in young minds, free of standardized ideas. Engineering students can cultivate it well under the guidance and stimulation of professors who view students as more important than courses. —J. E. Goodman, in *General Motors Engineering Journal* for May-June, 1955.

The 1955 ASAE Gold Medalists

Robert P. Messenger

The American Society of Agricultural Engineers Awarded the Cyrus Hall McCormick Medal to Robert P. Messenger and the John Deere Medal to Walter W. Weir at Urbana, Ill., on June 12

Walter W. Weir

THE story of the 1955 Cyrus Hall McCormick gold medalist is a saga of American opportunity and enterprise, an epitome of American trait and tradition, all the more intriguing because the man, for most of his life, was technically not an American at all.

"In 1854-56 or thereabouts," writes one of his friends, "Cyrus Hall McCormick exhibited his reaper at the World's Fair at the Crystal Palace in London, and received the highest award for it. Now, a century later, a man born in England and apprenticed there to an agricultural machinery manufacturer, at present executive vice-president of International Harvester, successor of the McCormick Harvesting Machinery Company, is being honored with the award of the McCormick Medal for meritorious work in the field of agriculture, embracing, amongst others, work in America on the harvester-thresher, successor of the reaper."

Robert Pocock Messenger was born February 1, 1888, at Little Milton, Oxfordshire, and lived his early years in the rural area near Oxford. At age 14 he began part-time work with the Haseley Iron Works, local builders of haying implements and distributors of Adriance harvesting machines built at Poughkeepsie, New York. When 16 he added the study of mechanical engineering at Oxford City Technical School.

In the year 1907, through the interest of William Adriance, he came to America in the employment of Adriance, Platt and Company. His people at home, believing this to be a short tour of duty, were surprised when it extended for three years and doubly surprised when in 1910 he changed his plan of returning to England and instead joined the International Harvester Company at Chicago. For over three decades his work was so truly international that it was 1947 before he had continuous sojourn of sufficient duration to earn American citizenship.

His first work for Harvester was with the old Champion Works at Springfield, Ohio, as draftsman and product engineer. He went to California and Washington for the first thorough study of the performance and economics of the harvester-thresher. His report still holds its place in the

(Continued on page 476)

IN A very literal sense, yet with full span of its symbolic meaning, award of the John Deere Gold Medal to Walter Wallace Weir does indeed give recognition "for distinguished achievement in the application of science and art to the soil." From ancient times men had watered the desert, but it remained for Walter Weir to make substantial contributions to the data and devise methods whereby the desert could be drained.

Born October 16, 1882, on the family farm at Vacaville, Walter was a second-generation California. His Scotch-Irish maternal grandparents had arrived via the Isthmus of Panama in 1852, not to dig the earth for gold but to farm it, and in 1854 was born his mother, Janetta Nicholl. His father, James Christopher Weir, whose ancestors were among the earliest of pre-Revolution settlers, came from Wisconsin in 1873 via the new transcontinental railroad.

Following graduation from the Vacaville Union High School and an interval on the home farm—a deciduous fruit ranch—Walter went to the University of California as a civil engineering student majoring in irrigation engineering. During junior and senior years he studied under the legendary Elwood Mead, and thereby acquired a precious friendship. It was at Dr. Mead's suggestion that, on graduation in 1907, Mr. Weir took the civil service examination and was appointed scientific assistant in the Office of Experiment Stations.

Thus began a decade of work with the U.S. Department of Agriculture. After a brief assignment in Greybull Valley, Wyoming, he devoted some three years, in advancing capacities, to drainage surveys in lower Mississippi Valley states. There he lived and worked with men who became famous in drainage and prominent in the profession of agricultural engineering. Among them he mentions Samuel H. McCrory, George R. Boyd, Lewis A. Jones, Dalton G. Miller, Fred F. Shafer, Arthur E. Morgan.

Some of those early colleagues recall rugged times with Walter. Jones tells how they were sent to a Texas town, which shall be nameless here except by the nickname it bore then—"Six Shooter Junction." Let off the train be-

yond the platform, they had trouble in finding it with not a light in sight, not even a star overhead. Came the dawn, and the reason—every street light shot out, and all windows boarded up solid. Shortly before, they learned, there had been a law-and-order meeting, and three people were killed at the meeting.

Recalled, too, was a time that Weir organized a party, steamed up the Black River in Arkansas, and pitched camp for a survey along Curia Creek. Cannily they picked a high point on the river bank for camp site. It turned out to be a sawdust pile, used as refuge by animals in time of high water, and left alive with fleas. Both Jones and Miller quote Weir's avowed ambition of those days—to sign his name Walter W. Weir, Walla Walla, Washington."

That never quite came to pass. But in 1910, when in Washington, D.C., writing up the Curia Creek report, he drew as his next assignment Yakima, Washington, where a new office needed a drainage engineer in charge. Three days after its first mention by Dr. C. G. Elliott, chief of the Division, Walter was on his way west, and he never again has been so far east.

As he tells it, he merely happened to be in the office when the Yakima job came along, but it was welcome as a chance to study what became his outstanding achievement—the drainage of irrigated lands. He fostered the formation of drainage districts, designed drainage systems for them and for individual farmers, and prepared the drainage district law for the state of Washington.

After three years of this, in 1913, he was borrowed by the University of California to tackle a task for which there was no one in that state, and for which Walter was the only specially qualified federal man in the Far West at that time. It was to reclaim some 5,000 acres of alkaline water-logged land at Fresno, owned by the University and known as Kearney Vineyard. Again, it just happened that he was given desk space in the department of soils, on the Berkeley campus, and thereby gained close contact with Charles F. Shaw, distinguished head of the department.

Need for drainage of irrigated lands

This, coupled with great need for drainage of irrigated lands in the state, led to his transfer in 1916 from federal service to the University. Starting nominally as assistant professor, he never was officially on the teaching staff, though at various times he did some teaching and advisory work with students. From 1926 onward he held the title of drainage engineer in advancing grades until in 1954 it became drainage engineer emeritus.

Overlapping this continuous career, in the decade 1925-35, he filled assignments of weeks or months with the federal departments of the interior and agriculture, and the successive Soil Erosion and Soil Conservation Services. From 1938 to 1948, in addition to other duties, he served as secretary for the State Soil Conservation Commission, whereby hangs a tale.

Weir's work in soil erosion started with a study in 1930, followed by an active part in setting up a demonstration project in Ventura County, and by continuing representation of the University in relation with the federal services. Upon formation of the state soil conservation commission it was natural that he became its secretary, in which capacity he examined every proposal for formation of a soil conservation district.

His policy was to approve proposals he deemed sound, but to report unfavorably in cases where the proposed district was insufficient in area or other essential. History has pretty well verified his wisdom, but at the time there were many whose enthusiasm outran their judgment. The commission, and especially Weir, was the target for a barrage of protest. Demand for his scalp became so strong that he was given the choice of resigning or being fired.

What happened is told by the third person present, then a colleague on the commission. Weir's instant and emphatic choice was to be fired. It hurt him deeply, but he could not yield to pressure when he knew he was right. Against his advice that district—the final straw—was organized. But four years later, in 1952, it was enlarged to the area originally specified as requisite by Walter Weir.

His firmness in the right appears in words by another friend and colleague, dating back to the Mississippi River surveys, who says: Perhaps Mr. Weir's greatest contribution has been his stubborn insistence on the now-accepted philosophy of deep (6 to 12 feet) drainage for irrigated lands. As a single example, in California now stands a beautiful lemon grove where before drainage was a salt pasture. Lemon trees are very susceptible to injury from soil alkalies and it was necessary in this case to install drains 12 feet deep. Dozens of similar cases could be cited to illustrate the correctness of Mr. Weir's steadfast belief."

Eminence in soil morphology

Along with his pre-eminence in the realm of drainage, and indeed augmenting it, is his eminence in soils, notably soil morphology and its influence in drainage. He has shared largely in soil classification and mapping for the University of California, and for federal agencies.

Writings by Mr. Weir are largely technical articles in a variety of appropriate periodicals, but they also include everything from mimeographed material to two-volume works, from the statutes of California to the bulletin of its San Quentin prison. A bibliography, probably partial, of fifty-odd titles includes a half-dozen feature articles, at intervals from 1922 to 1954, in AGRICULTURAL ENGINEERING.

It was in 1922 that Walter became a member of the ASAE. In 1929 he took the task of secretary of the Society's Pacific Coast Section, and has carried on with it ever since, except in 1939, when he was chairman of the Section. In 1933-34 he headed the Soil and Water Division of the Society, and in 1948-50 served on its governing Council.

Other of his memberships include the American Society of Civil Engineers and its San Francisco Section, Sigma Xi and Phi Sigma honor societies, Commonwealth Club of California, American Association for the Advancement of Science, Western Soil Science Society, Western Snow Conference, and National Parks Association. He is a registered civil engineer in California and holds one of the envied, below 100, registration numbers.

During many years of membership in the First Presbyterian Church of Oakland, Mr. Weir has served two terms as trustee, several as elder, and at least one as chairman of each major operating committee. For some years he has been chairman of the Faith Presbyterian Church Center Board, devoted to negro children of the vicinity, for whom he has acted as Santa Claus with all accoutrements. In earlier years he was active in Boy Scout leadership.

The Weir family includes four children—Walter W., Jr., whose mother died only five years after her marriage to Walter, daughter Janetta of the second marriage, and a son Eugene and daughter Elsie, children of his wife by a former marriage. There are eight grandchildren.

Mr. and Mrs. Weir are inveterate travelers, having covered just about every highway in the states, and many in Canada. Coupled with Walter's flair for color photography, their pilgrimages have produced a notable library of slides. They are renowned also as cribbage players. In some thirty years of play there are less than 20 points difference in their total scores.

Robert P. Messenger

(Continued from page 474)

Company files, and some of the principles it established still hold in current designs. Later he went to Argentina as field engineer following header-binders and strippers.

Next came a shift to the general office of Harvester at Chicago, in part for engineering attention to the Deering and Champion lines. More notable in perspective was his development, during this brief location, of the first standardized machine specification for the entire Company

In 1913 Mr. Messenger was sent to Europe to help organize engineering departments for the Harvester plants in France, Germany, Sweden and Russia. Soon came World War I, during part of which he also worked for the American Legation at Copenhagen, Denmark. Shortly after the war's end, in 1919, he became manager of engineering for all European plants, and manager of the patent department.

The next year, 1920, he was married, his bride being a Belgian girl named Ghislaine Monnoyer. Also in that year he became a member of the American Society of Agricultural Engineers. Thus began what probably is the longest absentee membership, for it was over two decades before his overseas tours ended and he was regularly resident in the States.

During these decades it was impossible for him to share directly in the activities of the Society. Yet the same vision which impelled him to seek membership, in that early time before it was routine for men of industry, inspired a mighty albeit indirect contribution to the Society. All along the years, increasingly with the expansion of his responsibilities, Mr. Messenger has encouraged many Harvester men to become members, and has facilitated their participation in Society work.

His work in Europe ended in 1936, but not for return to this country. Rather, he went to Australia and studied the requirements for farm machinery there, and the need for a local factory. In 1938 he was made general manager of the International Harvester Company of Australia Pty., Ltd. Besides directing the building of a complete manufacturing plant at Geelong, Victoria, he guided the development of a new line of machines specifically suited to Australian conditions, and also the development and production of varied war materiel for the Australian army.

At long last, in 1942, he returned to Chicago and as assistant to the vice-president was given charge of farm implement engineering. Upon creation of the "divisional organization" of his company, he was its first general manager of the farm implement division. In 1945 he was made a vice-president of the Company in charge of that division.

Two years later Mr. Messenger was made vice-president in charge of foreign operations, and in 1950 executive vice-president with direction of engineering and manufacturing groups in all divisions, his present position. Meanwhile, with five years of continuous residence, he acquired American citizenship in 1947.

To suggest the scope of Bob Messenger's engineering activity would be to run the gamut of just about every implement and farm machine used in Europe, North Africa, Australia, North America, and to some extent the other continents. Among them are the cotton picker, automatic baler and beet harvester of rather recent vintage, and also "stump-jump" plows and cultivators for Australia.

The story of the McCormick medalist abounds in paradox. He holds no academic degrees, and indeed his English technical school did not confer degrees. Yet among his sponsors are present and former heads of college agricultural engineering departments, including the first president of ASAE.

Despite the immense scope of his activity, technically and geographically, his only professional memberships are in the American Society of Agricultural Engineers and the American Society of Mechanical Engineers, in neither of which has he held office or carried on committee work. He never has belonged to any fraternal organization or scholastic honor society. He has been a member of the Royal Copenhagen Golf Club of Denmark, the Royal Golf Club de Belgique and the Union Club of Brussels, and the Frankston Golf Club of Victoria, Australia.

Fifty years of farm implement engineering

He gave one of the major addresses at the Centennial of Engineering Convocation at the Museum of Science and Industry, Chicago, in September of 1952. He has been speaker on other occasions, and author of many articles, but he never bothered to keep a bibliography.

While the diversity of detail in his fifty years of farm implement engineering defies selection for specific mention in this brief space, his sponsors and his colleagues in his own and other companies mention various of his achievements. They tell of his ability to analyze the need for and requirements of a machine, his vision in developing it by himself, or by others, his genius for organization and administration of engineering work, and perhaps most of all his gracious personality coupled with punctilious integrity.

He admits being a "do it yourself" man with a home workshop, and a collector of paintings and objects of art. Probably his greatest pride is his collection of fine and rare books, and friends tell how he would search for book treasures in all the places, great and obscure, where his work and travels took him.

The Messenger family include two sons and seven grandchildren. Both sons served in the United States Army in World War II. Leon, the older, rolled with Patton's tanks in the invasion of France. He is now in the sugar brokerage business in New York. John, the younger, a veteran of the Battle of the Bulge in Belgium, is district manager at Montreal for the Canadian subsidiary of International Harvester Company.

Agricultural Engineering in a Changing Economy

George B. Nutt
President, ASAE, 1954-55

IN THIS the 48th year of the American Society of Agricultural Engineers as an organized professional society, agricultural engineering has attained new heights in many ways. On June 1 we had 4418 members. This is an all-time high and a gain of 231 members since this date last year. The demand for graduates is without precedent. Twenty-five departments of agricultural engineering in our land-grant institutions have succeeded in securing accreditation by the Engineers' Council for Professional Development. Foreign countries friendly to our form of government are seeking the advice of our members in the solution of their many food and fiber problems. The segment of industry which provides equipment and engineering service to the farmer is relying more and more on the judgment and technical ability of the agricultural engineer. Many of our members are being selected for administrative positions in industry, government, and education.

The status of the profession at present is excellent and the future is bright. It is, however, necessary to take stock of those conditions which are not so favorable. To overlook this aspect would constitute negligence on the part of your officers.

Waning enrollment of students concerned our two immediate past-presidents, Ivan D. Wood and Edwin W. Tanquary. The demand for graduates far exceeds the number receiving degrees annually. Mr. Wood proposed that a movie be developed on agricultural engineering which could be used as a medium for recruiting students. Mr. Tanquary followed up on the suggestion to the extent of appointing a committee to consider the idea and secured Council approval to determine the feasibility of such a project. Your present Council has looked with favor on the idea and a movie should be a reality in the near future.

With the able assistance of Ralph A. Palmer, our assistant secretary, I approached the problem from the angle of what our membership enrollment was in 1940, 1950, and 1954. These years were selected arbitrarily but for rather obvious reasons. Only a limited number of college students had answered the call to the colors in 1940. Enrollment of veterans was considered at a peak in 1950. 1954 was selected to show where we stand comparatively with the prewar and postwar years, 1940 and 1950, respectively.

Enrollment data was obtained from 43 U. S. and three Canadian institutions where a professional curriculum or its equivalent is offered. The grand totals which include undergraduates and graduate students were 999 in 1940, 2282 in 1950, and 2067 in 1954. Considering the fact that the number of institutions offering a major in agricultural engineering has doubled since 1940, the present enrollment is not what it should be to meet demands for graduates. It is my opinion that there has never been a time in the history of our profession when the need for men is so great. We are back in a buyer's market where all classes of farm equipment must be designed to do the job properly and efficiently, manufactured to earn a profit for stockholders, and sold in sufficient quantity to provide steady employment to the industrial worker. The colleges and universities are called upon to provide engineers, mainly agricultural engineers, for these assignments. Manufacturers of farm tractors, implements, pumps, electrical equipment, prefabricated buildings, building materials, irrigation equipment, and other items, all are in the market for agricultural engineers. Most of our educational institutions are short-handed. The U. S. Department of Agriculture and other federal agencies found it necessary to increase their salary scale to compete with industry and educational institutions. Recently the head of an agricultural engineering department told me he kept a record of all requests received for men in 1954. The total was 73 and there were 12 graduates to consider the openings. Most department heads relate somewhat similar stories.

GEORGE B. NUTT

In the sense that scarcity of men has raised salaries, the present situation is healthy. But when all factors are considered the situation is not desirable. As an example, agronomists and civil engineers are being given assignments in the Soil Conservation Service which should logically be filled by agricultural engineers. Vocational-agriculture majors are being classified erroneously as farm machinery specialists by the Civil Service Administration in order to fill Point 4 positions which should be filled by agricultural engineers. Industry cannot wait for a new graduating class if their requirements are not met in a given year. They look to other professional groups. Most of our college departments are looking for men to teach, conduct research, or do extension work. They even find it necessary occasionally to seek men from other fields and often to their regret.

The big question is why is the enrollment less than we desire in the face of opportunity? Enrollment by departments in this school year ranged from a minimum of one to a maximum of 149. The average was 45 students per department. That included students in all classes and those working for advanced degrees. Five hundred and seventy or a little more than one-quarter of the number were enrolled in five departments representing institutions of the Midwest, Southwest, and Southeast. Twelve hundred and one, or about three-fifths of the total, were enrolled in one-third of the departments, leaving two-fifths, or 866 students, to be divided between 31 departments. Obviously many of the departments did not have enough students to maintain a full teaching staff.

I became interested in this subject in the spring of 1954 when I was invited to address the Southeast Section of the American Society of Engineering Education on the status of agricultural engineering in the Southeast. I looked forward to being able to tell this group about the progress our profession has made in this area. LSU, Mississippi State, Alabama Polytechnic Institute, North Carolina State, Clemson, and Florida have postwar buildings. Georgia has provided an annex and VPI has a top-rate prewar building. Provisions for research have mushroomed, our staffs are larger to teach service courses and conduct research and extension, but enrollment of professional students is low, although about one-quarter of the students are enrolled in the departments of the Southeast. In the discussion period that followed, a dean of engineering stated that his institution had provided a new building and equipment, ECPD had accredited the curriculum, the demand for graduates was good, but the enrollment was disappointingly low. He questioned the economy of maintaining a department for such a small number and suggested a regional approach to training agricultural engineers, such as we have for forestry and veterinary medicine. That scared me because we have worked diligently and against great odds to develop these departments and secure accreditation.

Mr. Palmer's survey added to my fear. One U. S. department reported a total of 6 students, 3 seniors and 3 sophomores. It was no surprise to learn a few weeks ago that the professional curriculum at that institution has been discontinued and the department has been taken over by the school of agriculture to teach service courses and be responsible for research and extension. Some other departments reported 9, 11, 14, 15, 21, and 23 students. As head of a department, I would be much concerned with such a small number of major students. I have been asked many times during the year what is responsible for small enrollment in some of our institutions. Some of our members think the responsibility for recruitment belongs to our national ASAE secretary and his staff. I beg to disagree. They can be a great help by providing recruitment literature, maintaining contact with student branches, assisting members with employment problems, and in dozens of unseen ways. The problem actually belongs to all of us. If industry needs our graduates, it must lend a hand. The Farm Equipment Institute has encouraged students by providing trophies, etc. Some ASAE sections have provided similar incentives. The departments of agricultural engineering must do a good job with the students and follow the progress of graduates.

Annual address of the President of the American Society of Agricultural Engineers before the 48th Annual Meeting of the Society at Urbana, Ill., June, 1955.

All of that isn't enough. We must get the story to high school students and I repeat *the problem belongs to all of us.* The teacher of vocational agriculture, the county agricultural agent, and the Soil Conservation Service employee can do a lot of recruiting, if we sell them on the field by doing a good job with our service courses, short courses, farmers' weeks, etc. Industry should give serious thought to providing scholarships. The same department head who recorded 73 requests for men last year told me that his college listed 33 scholarships, not a single one of them for agricultural engineers. Many companies with no more stake in agriculture than those closely allied with our profession are providing scholarships for students who wish to major in animal science, plant science, and other fields of agriculture. Individual companies, trade associations, and institutions should consider the merits of providing scholarships for future agricultural engineers. Some organizations such as electric power companies which serve only a few counties have established a precedent of providing a limited number of scholarships and fellowships. Farm publications are lending a helping hand by publishing career articles. The *Progressive Farmer* which serves all the states of the South featured agricultural engineering as its initial story in a series of career articles. This idea was supplied by one of our members, Fred A. Kummer of Alabama Polytechnic Institute.

A cumulative shortage of engineers has become a national issue. *Time Magazine* in its May 30th issue has this to say:

"The U. S. is currently in the grip of a shortage that Assistant Defense Secretary Donald Quarles ominously calls 'potentially a greater threat to national security than any aggressor weapons known.' That is the shortage of trained engineers. Just to keep pace with normal growth, the U. S. requires 30,000 new engineers annually; the new production burdens of the cold war require another 10,000 a year. But last year accredited U. S. schools graduated only 19,650 engineers—less than half the required number. Lacking engineers, U. S. companies have begun refusing government research projects. Caterpillar Tractor alone turned down six armed forces contracts.

"Not only is the engineer supply falling behind America's needs; it is also failing the U. S. in the military-technological race with the Soviet Union. Last year the Russians, who produced only about 9,000 engineers in 1928, have stepped up graduations until last year 53,000 were turned out—a rate of 2½ times greater than that of the U. S.

"Behind the U. S. engineering shortage lie a number of causes. One of the biggest is a survey made by the Bureau of Labor Statistics in 1949. It found that the U. S., then graduating close to 50,000 engineers a year, had too many. At the time, this was true enough. But shortly afterward, the Korean war and the boom in electronics and guided missiles transformed the picture. The industrial ratio of engineers to factory workers, which stood at one to 100 during the late '20s, has increased to 60, and is rising with every new automated process. But though the Bureau of Labor Statistics retracted its 1949 warning, the damage was done.

"High-school training is another cause of the shortage. Training in the sciences and higher mathematics should begin no later than the junior year in high school. But in the last 50 years, the proportion of high-school students studying algebra has dropped from 50 to 20 percent, physics from 20 to 4 percent. Says University of Illinois Engineering Dean William Everitt: 'We can't teach these boys algebra and geometry or primary physics and chemistry in the colleges.' Today MIT reckons one in four of its freshman engineering students to be poorly prepared, while Illinois Institute of Technology is only 60 percent filled for lack of properly qualified applicants.

"Finally, when the comparative handful of engineering students do graduate, the U. S. swoops down and puts 10,000 yearly into uniform. This leads to the peculiar spectacle of defense officials screaming for more engineers while inducting them into the armed forces, often to serve in jobs where their skills are not fully used.

"The result has been a mad scramble by U. S. companies for engineers. Teams of recruiters are swarming over every campus, wining, dining, and tempting seniors with beginning salaries 36 percent higher than in 1949 and about 4 percent above last year. An engineer-to-be can consider anywhere from 7 to 30 offers at salaries ranging from $320 monthly to twice that figure. One company even tried to hire MIT's entire graduating class. Zenith, in desperation, sent two executives to Holland on a shopping trip; they returned with ten good Dutch engineers. But the initial high pay gives a false impression of salaries for the long pull; ten years out of college, the average bachelor-of-science engineer earns only about $750 a month.

"In the frenzied competition, it is usually the big companies that win, while small companies, which are also conducting original research, are starved for talent. Many engineering school faculties are working intensively with secondary schools to improve their pre-engineering curriculums. Many companies are cooperating with colleges to develop training facilities—e.g., erection of a joint study center in South Windsor, Conn., to train 200 students was jointly announced last week by United Aircraft Corp. and Rensselaer Polytechnic Institute."

We, as agricultural engineers, do not anticipate and do not want mushroomed growth, but we do need more students to maintain strong, serviceable departments and provide the trained men demanded of our economy, which is dependent on such a small number for the products of the farm.

Some of our educators and political leaders are turning to the federal government for scholarships. Two bills have been introduced in Congress to subsidize scientific training. Representative Powell, New York Democrat, introduced a national defense scientific education act which would provide annual scholarships for 25,000 candidates for scientific and engineering degrees at a yearly cost of $50,000,000. A more modest bill was introduced by Representative Osmers, New Jersey Republican, which would train 1,000 candidates a year.

I do not concur that the U. S. Government should provide the scholarships. There would be too many strings attached. Educational institutions with the support of American industry should encourage talented young men and women to remain in school and offer incentives to the most deserving.

It is my opinion that none of Russias 53,000 engineering graduates of last year could be classified correctly as agricultural engineers. I have been in some of the countries of the Middle East and there was no modern Russian farm equipment to be found. U. S., Canadian, United Kingdom, French, and German equipment was in evidence. It stands to reason that Russia has neglected agricultural engineering in her economy and is now faced with a shortage of farm products. We cannot afford to follow suit.

Administration of Agricultural Engineering Research by the USDA

Administration of the USDA is linked with the supply and demand of technically trained men. Recent changes have split agricultural engineering into several service groups. A brief history of agricultural engineering research and some of the problems related to the present arrangement follow.

In 1890 the Office of Irrigation Inquiry was established by USDA, which represents the organized beginning of agricultural engineering by the Department. Since that date research in this field has been administered as follows:

1898 Division of Irrigation Investigations in the Office of Experiment Stations

1904 Division of Irrigation and Drainage Investigations in the Office of Experiment Stations

1906 Division of Farm Management Investigations in Bureau of Plant Industry (included research on both machinery and structures).

1908 Division of irrigation Investigations, Division of Drainage Investigations, and Office of Experiment Stations

1915 Three divisions of agricultural engineering were established in the Office of Public Roads and Rural Engineering: (a) Division of Irrigation, (b) Division of Drainage, and (c) Division of Rural Engineering (water systems, sewage disposal, machinery and equipment, structures.)

1920 Office of Public Roads and Rural Engineering changed to Bureau of Public Roads

1925 Division of Agricultural Engineering established in Bureau of Public Roads

1931 Bureau of Agricultural Engineering established with the following divisions: (a) Irrigation, (b) Drainage and Soil Erosion Control, (c) Mechanical Equipment, (d) Structures, and (e) Plans and Service.

1939 Combined with Chemistry in the Bureau of Agricultural Chemistry and Engineering, except Irrigation, Drainage and Erosion Control research which was transferred to the Soil Conservation Service.

1943 Agricultural Engineering Research transferred to Bureau of Plant Industry, Soils and Agricultural Engineering

1952 Drainage, soil erosion, and part of irrigation research transferred from Soils group in Bureau of Plant Industry, Soils and Agricultural Engineering to Soil and Water Conservation Research Branch

1953 General Reorganization of Department of Agriculture

- (A) Establishment of Agricultural Engineering Research Branch including all engineering research except soil and water engineering and engineering research in the field of marketing
- (B) All soil and water engineering research placed in the Soil and Water Conservation Research Branch.
- (C) Engineering research in the field of marketing placed in branches of the Agricultural Marketing Service.

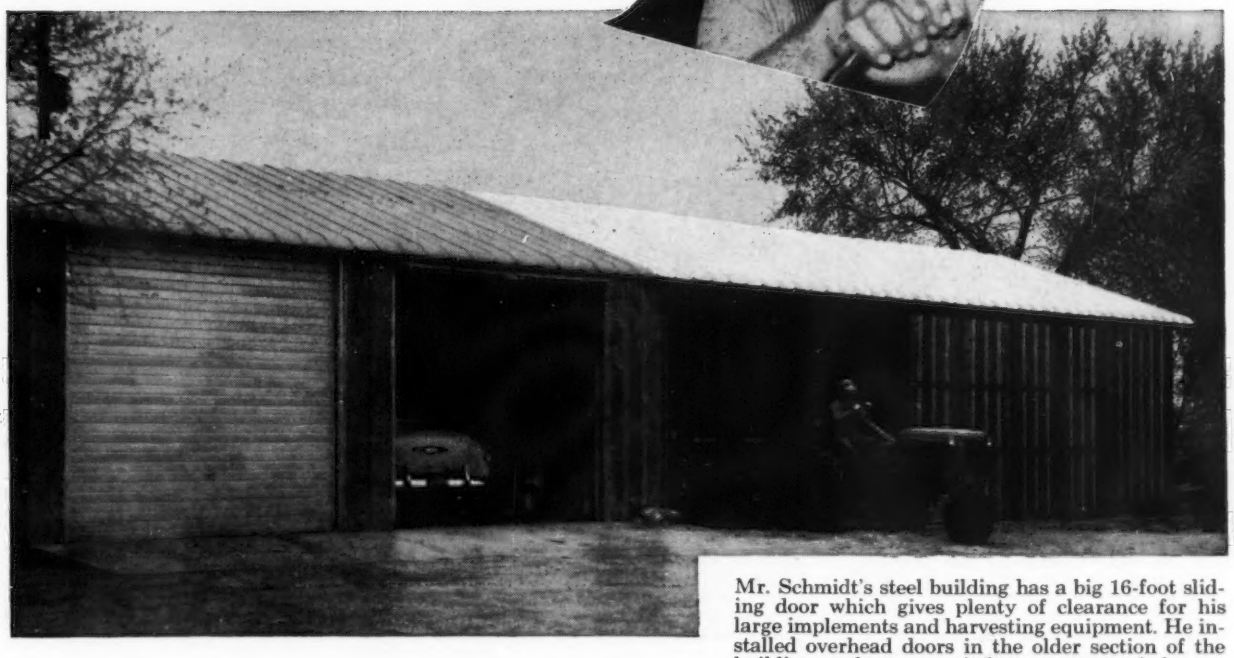
Many of us who have considered the effects of these organization changes look upon the last one as being little short of disastrous. Approximately one-quarter of the USDA research engineers are not responsible to the chief of the Agricultural Engineering Research Branch. Their work is directed by agronomists, soil scientists, marketing specialists, etc. The philosophy of this administration is "organization around main problem areas rather than around academic disciplines." That may sound impressive but professional deterioration with all the attendant ills is bound to follow. The Marketing Service divides their engineering requirements into agricultural, mechanical, electrical, etc., as a justifiable "problem area" set-up. But it is interesting to note that several graduate agricultural engineers assigned to marketing research have been classified conveniently as mechanical engineers by Civil Service.

In the Soil and Water Conservation Research Branch there are several agricultural engineers employed. One or more occupy minor administrative positions. Be assured they are not calling the signals. In the

(Continued on page 482)

"I'm completely sold on all-steel buildings ...very little upkeep ...long life ...lower over-all cost"

says Walter E. Schmidt, Columbus, Nebraska



Mr. Schmidt's steel building has a big 16-foot sliding door which gives plenty of clearance for his large implements and harvesting equipment. He installed overhead doors in the older section of the building, and now uses it for a garage and shop.

Five years ago, Mr. Schmidt erected a 24' x 24' steel utility building on his farm. Just recently, he and his son, working in their spare time, added a 40-foot extension to it. "The old and new sections of my all-steel building match so well —fit so perfectly—you would think they were built about the same time instead of five years apart," says Mr. Schmidt.

Mr. Schmidt chose steel buildings for his farm because, in his own words, their "all-steel construction requires little upkeep for long life," and results in "lower over-all cost than other types of construction."

You, too, will find that construction with steel is economical. And you'll be highly pleased at the versatility of steel buildings since they are just right for dairy cattle housing, grain and machinery storage, or poultry housing. They are big, strong, roomy, tight and dry, fire resistant and easily grounded against lightning. Don't wait. Prepare for the coming winter *now* by investing in a Factory-Built Steel Farm Building manufactured with long-lasting USS Galvanized Steel Sheets for roof and walls, and a USS Structural Steel framework.

When buying a Factory-Built Steel Farm Building, ask for USS Galvanized Steel Sheets for roof and sides. These sheets have a zinc coating produced to ASTM Specification A-361. This is your assurance of a high quality building.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

SEND THIS COUPON FOR FURTHER INFORMATION

Agricultural Extension Section
United States Steel Corporation
Room 4730, 525 William Penn Place
Pittsburgh 30, Pa.

I am interested in steel buildings for the following:

- ☐ machinery storage
- ☐ hay storage
- ☐ grain storage
- ☐ other .....
- ☐ dairy barns
- ☐ cattle shelters
- ☐ poultry houses

Approximate size or capacity .....

☐ **Please have a Steel Building representative call on me with further information.**

Send information to:

Name .....

Address .....**Town** .....

County .....**State** .....

United States Steel Corporation produces high-quality USS Galvanized Sheets and Structural Steel which our customers manufacture into durable farm buildings. Your requests for information will be forwarded to the manufacturers of these buildings, and you will hear directly from them.

NEWS SECTION

The "Journal" Adds to Its Editorial Staff

JAMES A. BASSELMAN has been appointed to the newly created position of associate editor of AGRICULTURAL ENGINEERING.

Mr. Basselman is a 1952 agricultural engineering graduate from Michigan State College and for the past three years has been on the editorial staff of *Farm Implement News*, Chicago. He gained his editorial experience under the guidance and supervision of Editor Elmer J. Baker, Jr. During his employment with *Farm Implement News*, he was also editor of the *Tractor Field Book*, a widely used farm equipment reference manual.

Jim, as he prefers to be called, was born on a farm near Barton City, Mich. His early boyhood was spent on his father's farm where he picked up farm experiences first hand. He selected vocational agriculture as his high school major and served as vice-president of Harrisville High School FFA chapter.

Early in 1943 he was called into the armed services. During the first year of his military life he attended South Dakota State College under the Army Specialized Training Program. Upon completion of the course, Jim was shipped overseas and served as squad leader with the 34th Infantry division in Italy.

JAMES A. (JIM) BASSELMAN

He returned to the states in 1946 and was soon discharged. Before continuing his college training he spent two years teaching a rural elementary school.

Jim is married and the father of three children. He is active in church work and holds membership in veteran's and fraternal organizations.

1955 ASAE Annual Meeting Records Progress

A SPIRIT of living up to the challenge of our times was in the air at the 48th Annual Meeting of the American Society of Agricultural Engineers at Urbana, Ill., June 12 to 15. An enlarged concept of what agricultural engineers can, should and will do in the over-all expansion and utilization of technology was evident in both the scheduled and the informal exchange of information and ideas on progress, continuing problems and new approaches in the field.

Something of a new record attendance at an ASAE annual meeting was set with a count of 690 paid registrations, 276 women and 127 children—total 1,093.

Preliminary activities started Saturday, June 11, with the Council opening its meeting at 4:00 p.m. Other early arrivals were starting to set up extension exhibits, and the local committee was putting the finishing touches on its setup for handling registrations. The Public Relations Committee was establishing its press room to continue its program of letting the public know about the meeting and its significance.

Traffic converged at the Illini Union all day Sunday, June 12, with members arriving for the registration starting at 2:00 p.m., the Cabinet meeting at 3:00 p.m., the buffet supper at 5:00 and the evening entertainment at 7:30. The entertainment opened with an exhibition of tumbling, balancing, trampolining, and acrobatics by a dozen children, teenagers and university students under the direction of Professor Charles Pond, University of Illinois. This was followed by music, provided by the Champaign-Urbana Chapter of the SPEBSQS.

A report on the Society's motion picture project, by E. W. Tanquary, was one of the main items of consideration at the Sunday afternoon Cabinet meeting. He brought the Cabinet up to date on planning and organization for production and financing of the picture. Other matters presented to the Cabinet included remarks on arrangements for the annual meeting, by Deane G. Carter; minutes of the previous meeting, by Frank B. Lanham; activities of the Secretary's office and progress in membership promotion by F. B. Lanham, the Centennial of Farm Mechanization and the 50th annual meeting (1957) of the Society at Michigan State University by W. M. Carleton; the 1956 annual meeting at Roanoke, Va., by James H. Lillard, and a student recruiting project of the Iowa-Illinois Section by Roy E. Harrington. A roll call showed a large proportion of the Sections represented.

Monday forenoon the meeting shifted into high gear with 6 concurrent programs from 9:30 to noon; each of the four technical divisions, Education and Research Division, and the student group were in session.

Organized tours and special events provided an equally wide choice of activities on Monday afternoon.

The combination of afternoon riding, walking, and cool weather provided appetites to make the most of the chicken barbeque provided at the supper hour. Square dancing at the Union completed the family party entertainment of the evening.

Tuesday's program started at 8:30 a.m. with a meeting of the extension agricultural engineers and a student session, and meetings of the Committees on Electric Infrared Brooding, Farm Structures Research, Nomenclature for the Soil and Water Division, Evapotranspiration, Interrelationships of Highway and Agricultural Drainage, and Farm Work Efficiency.

A surface drainage seminar started at 9 a.m. The regular sessions of the four technical divisions reconvened at 10 a.m.

The president's annual address, by Geo. B. Nutt, was the feature of the general program Tuesday afternoon. Following the president's address, the first award student paper was presented by its author, Gerald L. Zachariah, of the Kansas Student Branch. His subject was "Strain Gage Measurement of Draft."

At the annual business meeting which followed, special reports were presented on public relations by K. L. Pfundstein, on student branch activities by C. L. Zink, on the work of the Scientific and Engineering Manpower Commissions and on activities of the ASAE special committee on engineers' classification in civilian and Military service by T. E. Hienton, and on the Centennial of Farm Mechanization at Michigan State University by Don Brown. A progress report was presented for the Committee on ASAE History.

The ASAE annual dinner program Tuesday evening, with Fred A. Kummer as master of ceremonies, featured musical selections by Bruce Foote, professor of music, University of Illinois and Mrs. W. B. Browder, daughter of Professor and Mrs. W. B. Lehmann; the presentation of awards by president George B. Nutt; an address by Clayton Rand, editor and speaker, of Gulfport, Miss., and inauguration of the new president, Wayne H. Worthington. Past-presidents of the Society (and their wives) attending and seated at a special table included Dr. J. B. Davidson (first president), 1908; Howard W. Riley, 1912; Raymond Olney, 1919; E. W. Lehmann, 1923; O. W. Sjogren, 1926-27; William Boss, 1928-29; W. G. Kaiser, 1929-30; L. J. Fletcher, 1931-32; C. E. Seitz, 1932-33; G. W. McCuen, 1934-35; Arnold P. Yerkes, 1937-38; S. P. Lyle, 1938-39; H. B. Walker, 1942-43; J. D. Long, 1945-46; A. J. Schwantes, 1948-49; Frank J. Zink, 1949-50; F. C. Fenton, 1950-51; Stanley M. Madill, 1951-52; Ivan D. Wood, 1952-53; and E. W. Tanquary, 1953-54.

Robert P. Messenger, executive vice-president of International Harvester Co., and member of ASAE since 1920, received the Cyrus Hall McCormick Medal; and Walter W. Weir, drainage engineer emeritus, University of California, ASAE member since 1922, and long-time secretary of the Pacific Coast Section, received the John Deere Medal. *(Continued on page 482)*

ASAE Meetings Calendar

August 22-24—NORTH ATLANTIC SECTION, University of Connecticut, Storrs

October 19-21—PACIFIC NORTHWEST SECTION, Portland, Ore.

October 20-21 — PENNSYLVANIA SECTION, Holiday Motor Hotel, Gettysburg, Pa.

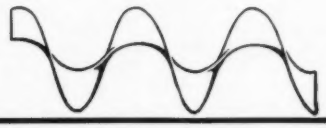
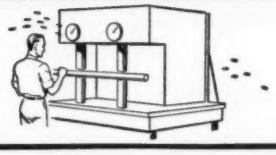
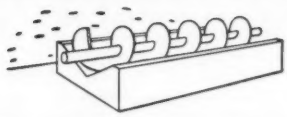
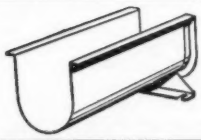
December 12 to 14 — WINTER MEETING, Edgewater Beach Hotel, Chicago

June 17-20—49TH ANNUAL MEETING, Hotel Roanoke, Roanoke, Va.

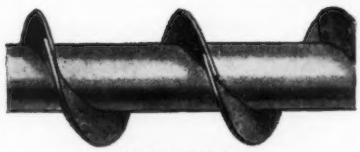
NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Before you buy AUGERS . . . rate them against this quality chart

LINK-BELT gives you all these performance extras

ONE-PIECE HELICOID FLIGHTING		Continuous flighting has greater smoothness and strength. Link-Belt also builds many different types to meet your special needs—cut flight, short pitch, ribbon flight, tapered flight, double flight to name a few.
UNIFORM PITCH		Consistent, accurately-formed flighting is produced by specialized modern machinery.
STEELS THAT MEET OUR SPECIFICATIONS		Selected steel for flighting, assures a uniform, smooth, accurately rolled product.
STRAIGHTNESS		Straightness of the completed auger is checked before shipping. Extra care is taken in handling and loading.
ALL COMPONENTS		A full line of related equipment can be supplied by Link-Belt specially engineered for your requirements. This includes troughs, spouts, hangers, drives.

Typical examples of LINK-BELT AUGERS



Sectional-flight

Helicoid flight with plain beater

Helicoid flight

Unmounted Helicoid flighting

Opposed flights with center saw-tooth beater

These are only a few of the many important performance extras you get with Link-Belt augers. Ask your nearest Link-Belt office for 92-page Data Book 2289.

LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.600

NEWS SECTION

(Continued from page 480)

A notable addition to the usual list of awards was the presentation of the 1954 Scott award to John B. Powers for his development of electronic color sorters for fruits and vegetables. Previous recipients of award include such names as Thomas A. Edison, Guglielmo Marconi, Orville Wright.

Authors and titles in the Journal Paper Award list were L. E. Elfes, "Design and Development of a High-Speed Mower;" T. E. Bond, C. F. Kelly and N. R. Ittner, "Radiation Studies of Painted Shade Materials;" H. K. Johnson and A. C. Dale, "Heat Required to Vaporize Moisture;" H. B. Walker, "Balancing Agricultural Engineering Research;" G. L. Nelson, G. W. A. Mahoney, E. R. Berousek, and Frank Graybill, "Hot Weather Shelters for Livestock."

Cited as Student Honor Award winners for outstanding scholarship and participation in student activities were John S. Balis, University of Wisconsin; John H. Body, Pennsylvania State University; Wm. J. Boston, Oklahoma A & M College; Joe M. Bunn, North Carolina State College; Kenneth W. Campen, University of Missouri; Ferol S. Fell, Kansas State College; Kenneth A. Fineran, Iowa State College; Lester W. Hammond, Jr., University of Maine; Clifford L. Jenson, Oregon State College; Vernon E. Rettig, Colorado A & M College; John J. Robinson, Pennsylvania State University; Joseph J. Shindelar, Iowa State College; James E. Smith, University of Illinois; Harry W. Stanhope, University of Maine; Daniel A. Van Duyne, Pennsylvania State University; Peter F. Van Houten, University of Idaho; Wendell Ver Ploeg, Iowa State College; Paul E. Wagner, Washington State College; Joseph A. Willhelm, Texas A & M College, and Gerald L. Zachariah, Kansas State College.

FEI Trophy Awards were presented at a student luncheon Wednesday noon with the compliments of the Farm Equipment Institute. The Pennsylvania Student Branch was the Group A winner, with honorable mention to the Iowa and Maine Branches. North Carolina took the Group B trophy, with the Oklahoma and Missouri Branches receiving honorable mention.

Frank P. Hanson, chairman of the FEI Research Committee, presided at the luncheon. He introduced Bruce Lourie, president of FEI, who extended brief greetings to the students, faculty representatives and industry men present. Richard Cade, chairman of the FEI Award Committee, presented the trophies and certificates. Henry J. Barre, consulting agricultural engineer, spoke to the group on "The Graduate Engineer and His Opportunities for Service."

Following the luncheon the students convened for their closing session and election of 1955-56 officers of the National Council of ASAE Student Branches.

Technical sessions occupied both the morning and afternoon programs on Wednesday. The Farm Structures Division clearly demonstrated what could be done to hold an audience to the end of the meeting. Its concluding speaker was R. Buckminster Fuller, noted architect and visiting professor at North Carolina State College. His illustrated report on research in lightweight tension members for farm building construction proved of great interest to a large audience. It dealt largely with dome-shaped enclosures, triangular framing units, and light coverings of plastic and other materials.

A separate report on the extension exhibits will appear in an early issue.

North Atlantic Section Meets August 22-24

THE program committee of the North Atlantic Section of the American Society of Agricultural Engineers has promised an excellent program of topics and speakers for the Section meeting to be held at the University of Connecticut, Storrs, August 22-24.

A welcome address by the president of the University will officially open the meeting on Monday afternoon, August 22. Wayne H. Worthington, national president of ASAE, will follow with an address concerning the Society. To round out the Monday program, Herrell DeGraff of the school of nutrition, Cornell University, will speak on agricultural economics. In addition, it is hoped to have a speaker either on the subject of the St. Lawrence seaway and power project or on atomic radiation for food preservation.

All of Tuesday, August 23, will be given over to sessions of the four technical divisions. The Soil and Water program will include papers on well-point batteries, flood damage by Hurricane Hazel, use of diversion ditches or terraces, watershed benefits, historical development of tile drainage, water supplies for irrigation, and educational work of the Sprinkler Irrigation Association.

The Farm Structures program will include two papers on development in improving concrete silo construction and maintenance, two papers on paint development, and a talk on the capture and retention of solar heat.

A half-day joint session of the Farm Structures and Rural Electric groups is in the plans for Tuesday afternoon.

The Rural Electric program includes talks on grounding, farm wiring materials, safety factors in brooding, and stand-by generating units. The Power and Machinery program was not reported.

Wednesday morning, August 24, a general program is planned on the general subject of ravages of wind and water. This will include a movie of the New England hurricane.

The annual business meeting will follow the morning session and the Section banquet in the evening will conclude the program.

Agricultural Engineering in a Changing Economy

(Continued from page 478)

words of one of this number, they are "carriers of water and hewers of wood."

The disintegration of "academic disciplines" has raised protests from groups other than agricultural engineers. Home economists and farm economists are not happy. Many of the farm economic leaders voiced their feelings in the February, 1954, *Journal of Farm Economics*.

O. V. Wells explains that "the Marketing Service will be responsible for all marketing research, whether economic, engineering or biological."

Paul H. Appleby in his concluding remarks stated that "the probability is that dissemination of economic research will weaken such research, not strengthen it. It would seem fair to say that the Secretary of Agriculture will be more poorly served than he has been in the past, whether he knows it or not. It may be also asserted with confidence that the Department of Agriculture has become a place much less attractive to first-rate economists—."

Dr. Henry C. Taylor stated that "the Department has now been divided with no common denominator except the Secretary himself—the team organized for one problem may not be the team fitted for the next problem. The teams will need to be made up anew with each change in the character of problems—."

"A department of Agriculture organized around particular problems is in danger of letting fundamental research fall between—" Summarizing, Dr. Taylor asked the following question and answered it: "With the economic work split up and scattered, who will maintain the scientific research; where, in years to come, will the supply of men be found for problem teams, and who will lay the foundations of progress? Frankly it appears a road has been chosen that leads to disintegration of the scientific work and the deterioration of the application of science to the solution of farm problems and the blazing of trails of progress." I endorse these lines of reasoning and by substituting the words "agricultural engineering" for "economic" I submit that the statement applies to our field of research.

Where would we be today in our colleges and universities if our departments of agricultural engineering were disintegrated and drastically reorganized an average of every six and a half years. What continuity of resident instruction, research, and extension could we anticipate? Fortunately, our college departments are not governed by political expediency and are not forced to weather such disastrous changes.

I think the time has come when we must follow the precedent established by the home and farm economists and let our leaders in Washington know where we stand on the reorganization issue. I have talked with former bureau chiefs, directors of the newly created divisions, many of the agricultural engineers of the Agricultural Engineering Research Branch, the Soil and Water Research Branch, and the Research Division of the Marketing Service. With the possible exception of some who have profited by the changes, no one is satisfied.

Does it make sense for engineering research to be split three or more ways? To me the answer is emphatically No! There does not seem to be any logical reasoning against the organization of agricultural engineering research into one branch or division. Cooperation with all divisions of ARS and the Marketing Service should be fostered. This arrangement would permit the agricultural engineering administrator to select men from his staff particularly qualified for the problems as they arise. It should also result in (1) gaining approval of ASAE members, (2) in attracting more good men into government service, and (3) in giving the tax payer more for his money.

It has been rumored that some of the number responsible for the last USDA reorganization advocated that agricultural engineering should not even be permitted a separate branch. Rumor is a dangerous weapon, but there are obviously forces responsible for the disintegration of agricultural engineering in USDA. This affects the Society adversely and ultimately will affect the college agricultural engineering departments, the backbone of the profession, in like manner.

Although in this address I have pointed out two of the principal problems affecting our profession, namely, the shortage of graduates and problems arising from the reorganization of the U. S. Department of Agriculture, I am confident that ASAE is gaining in prestige and in its ability to serve society. Our membership is growing and our graduates are trained well to serve the most basic of all industries—agriculture.

A report to you about men and machines that help maintain International Harvester leadership

How IH engineers coordinated
Power and weight for pull and performance in the

NEW INTERNATIONAL® 300 UTILITY TRACTOR

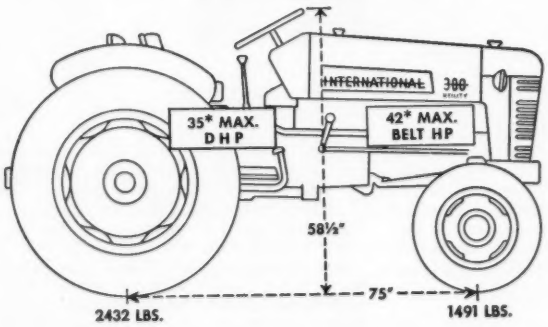
IH engineers designed the new International 300 Utility tractor around a heavy-duty tractor engine delivering 42 hp* on the belt and 35* at the drawbar. Then, to provide the *correct power-weight ratio* for full 3-plow capacity, they strategically built in up to 1,000 pounds more weight than is common to tractors of this type. The result is *strength and stamina for the long-pull* . . . a cardinal principle of IH design.

Further, IH engineers made it possible for each user to obtain the degree of power flexibility he needs to match particular requirements. In addition to Fast-Hitch and adapter for 3-point equipment, the new International 300 may be obtained with:

- *Torque Amplifier drive*, providing two speeds in each of the five regular gears, enabling the operator to change speed and boost pull-power on the go.
- *Power take-off*, either *completely* independent or transmission-driven.
- *Hydra-Touch equipment control*—live hydraulic power with one, two, or three-valve control of single or double-acting cylinders. Front and rear mounted equipment may be controlled individually or simultaneously.

The result of International 300 Utility tractor design is exceptional tractive efficiency, combined with operator comfort and convenience that raises utility tractor performance to new high levels!

**Estimated: not officially tested.*



The correct power-weight ratio for heavy-duty service

This drawing tells why the International 300 Utility tops the all-duty tractor field for strength and traction: *up to 1,000 pounds more built-in weight!* Weights shown include Fast-Hitch, Torque Amplifier, and 3-valve Hydra-Touch; without operator, fuel, or coolant. Weight is correctly distributed for maximum strength and stability and efficient traction.

IH engineering teamwork produced the versatile new International 300 Utility—a tractor truly designed and built for the long pull. IH research, engineering, and manufacturing men are constantly pooling time and talent to provide equipment of improved performance to make the user's work easier while boosting production.

INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois

NEWS OF ASAE MEMBERS

Robert W. Trullinger, Life Fellow of ASAE, retired as assistant administrator for experiment stations (ARS), U. S. Department of Agriculture, on June 1 after 43 years' service.

DR. R. W. TRULLINGER

Dr. Trullinger has been a leading advocate of close cooperation between the states and the federal government in agricultural research, and between research and extension work for the improvement of the nation's agriculture. He is widely known at state land-grant colleges and universities throughout the country, both for his work with the experiment stations and for his leadership in establishing agricultural engineering as a profession.

In 1941, ASAE awarded the John Deere Medal to Dr. Trullinger, stating that "the long-range objective of his life had been to direct all research toward fundamentals, to probe ever deeper into the secrets of the soil, yet always to select for study such matters as shall, in final and practical application, work to the weal of agriculture and of mankind."

The Department of Agriculture presented Dr. Trullinger in 1953 with its Distinguished Service Award, "for vision and leadership in research administration, which has been a vital force in fostering strong federal-state relationships and in achieving an efficient, well-coordinated total agricultural research program."

A native of Farragut, Iowa, Dr. Trullinger graduated from Iowa State College in 1910 with a B.S. degree in civil engineering. In 1925 he received the professional degree of agricultural engineer from the same institution. Rutgers University awarded him the honorary degree of doctor of engineering in 1941.

Dr. Trullinger is a past-president of ASAE, and served for years as member or chairman of the Society's research committee. From 1931 to 1936 he was active on American Engineering Council.

•

J. F. Schaffhausen has been named assistant president of Cockshutt Farm Equipment, Inc., Bellevue, Ohio. In his new capacity Mr. Schaffhausen will direct all phases of management and marketing for the company.

J. F. SCHAFFHAUSEN

Mr. Schaffhausen is chairman of the board of The Schaffhausen Corp., Irvington-on-the-Hudson, N. Y., an agricultural research and industrial management firm, which Mr. Schaffhausen founded 21 years ago. He is also president of the Open Gate Experimental Farms in Pennsylvania, New Mexico, Nevada and Quebec.

Mr. Schaffhausen is a past-chairman of the ASAE Farm Structures Division.

William A. Hewitt, an ASAE member since 1954, executive vice-president of Deere & Co. since July 15, 1954, and a director since 1951, was elected president of the company at a special meeting of the board of directors May 24. He succeeds the late Charles Deere Wiman, who died May 12.

W. A. HEWITT

Mr. Hewitt was born in San Francisco August 9, 1914, and received his education at the University of California and the Business School of Harvard University. Previous to joining the John Deere organization in 1948, he had spent several years in the banking business and also had been employed by the Pacific Tractor and Implement Co. at Richmond, Calif. He was vice-president and general manager of the John Deere Plow Co. of San Francisco before being elected executive vice-president of Deere & Co. last year.

Mr. Hewitt was in the United States Navy during World War II, attaining the rank of lieutenant-commander. He served on the USS California and the USS St. Louis, and participated in several important engagements in the Pacific.

Mr. Hewitt is Deere & Co.'s sixth president in its 118-year history. His predecessors were John Deere, Charles Deere, William Butterworth, Burton F. Peek (now chairman of the board), and Charles Deere Wiman.

•

George E. Spencer has been named as head of the department of agricultural engineering at Purdue University, effective July 1. He succeeds Henry J. Barre who resigned two years ago.

G. E. SPENCER

Mr. Spencer was graduated from Purdue University in 1927 with a civil engineering degree. He taught civil engineering for a year at the University of Maine and a year at the University of Illinois. In 1929 he accepted a position as teacher of farm drainage and surveying at Purdue University. Seven years later he was made an assistant professor. He became an associate professor in 1938 and was advanced to full professorship in 1946. He has served as acting head of the agricultural engineering department for the past two years.

•

Harold E. Hale has resigned his position with the Anderson Truck Terminal at Maumee, Ohio, to become a service engineer with Rilco Laminated Products, Inc., for the southern Ohio area.

•

William H. Peterson has resigned as electrification adviser for the Lake Region Electric Assn., Webster, S.D., to accept a position as rural electrification specialist with the extension service of South Dakota College, Brookings.

Byron T. Virtue, chief engineer, Bearings Division, The Torrington Company, Torrington, Conn., has been elected by the Company's board of directors to the newly created position of vice-president of engineering.

B. T. VIRTUE

In 1945 Mr. Virtue joined The Torrington Co., which operates 10 plants in the United States, Canada, England, and Germany, as assistant chief bearings engineer. Shortly thereafter he was made chief engineer of the Bearings Division.

Mr. Virtue is a native of Iowa and an agricultural-engineering graduate of Iowa State College where he received his bachelor's degree in 1931 and a master's degree in 1932. While in college he was engaged in his spare time in work for the agricultural engineering section of the Iowa Agricultural Experiment Station, much of which was devoted to building and testing experimental power-farming equipment being developed by the section. Later he was employed for several years as an extension specialist in agricultural engineering for the Iowa Agricultural Extension Service, which included work in planning and conducting projects on farm machinery repair and adjustment and a variety of other agricultural-engineering activities.

Mr. Virtue is currently chairman of the ASAE Power and Machinery Division.

•

Arthur W. Farrall, head of the department of agricultural engineering at Michigan State University, East Lansing, received an honorary doctor of engineering degree at the University of Nebraska commencement in Lincoln, June 13.

A. W. FARRALL

Mr. Farrall returned to his native state to receive the honor. Born at Harvard, Nebr., he graduated from the state university in 1921 with a B.S. degree in agricultural engineering. In the following year he earned an M.S. degree. He did additional graduate work at the University of California.

From 1932 until the time he joined the staff at Michigan State, he did commercial research work in dairy manufacturing. He developed numerous pieces of dairy plant equipment and has written a college textbook on *Dairy Engineering*.

Since coming to East Lansing he headed the program which included the construction of the modern Michigan State agricultural engineering research and teaching center. He is currently serving as chairman of the Centennial of Farm Mechanization to be held on the Michigan State campus, August 15 to 20.

•

William A. Bailey has resigned his connection with the Niagara Chemical Division, Food Machinery and Chemical Corp., to join the mechanical preparation and condition section of the U.S. Department of Agriculture, and is stationed at Storrs, Conn.

(Continued on page 486)

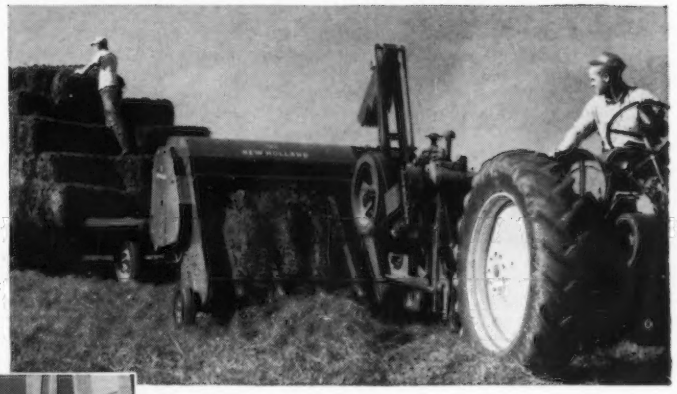
BCA PLUNGER ROLLER BEARINGS

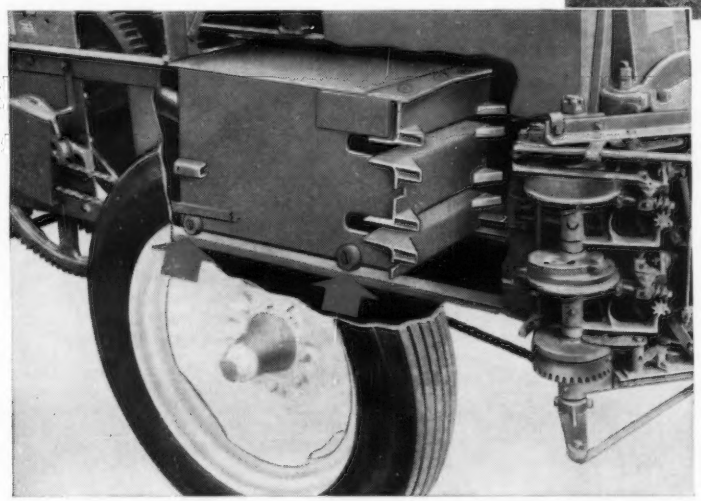
give "smoother, more efficient operation"

on New Holland Super "77" Automatic Baler

New Holland Machine Company, Engineering Division, reports on BCA *package unit* bearings:

1. **Effective sealing**—proved in laboratory tests and under extremely dusty field conditions.
2. **Convenience**—sealed bearing, outer shoe, and mounting stud are all built into one compact unit.
3. **Long life in the field.**
4. **Low rate of wear**—maintain close plunger knife adjustment.
5. **Save power**—low friction results in an easy rolling plunger.





Cutaway view shows how BCA plunger roller bearings are designed into baler. Package units are built with thick-section outer ring, hardened throughout, specially adapted for rolling heavy masses on rails. Available with crowned or V-groove OD.

In this automatic pick-up baler, the plunger runs on BCA sealed, pre-lubricated ball bearings. This means fewer adjustments; lower maintenance costs; and smoother, more efficient operation for the farmer. *Package units* of sealed bearing, outer shoe, and mounting stud speed up and simplify assembly for the manufacturer.

If you have a bearing problem, BCA engineering cooperation and design assistance will provide the positive solution.

If you've got a bearing problem, contact:

BCA

BEARINGS COMPANY OF AMERICA

DIVISION OF FEDERAL-MOGUL CORPORATION

LANCASTER • PENNSYLVANIA

Pioneers of pre-lubricated *package unit* ball bearings for agriculture

News of ASAE Members

(Continued on page 484)

Finis T. Wratten, formerly associate agricultural engineer in the USDA, stationed at Louisiana State University, has joined the agricultural engineering staff of the University and is working on grain drying and storage problems.

•

William A. Calvert, Jr., is now a sales engineer with the Delco Products Division of General Motors Corp. He was formerly with Reynolds Metals Co.

•

William H. Jenkins, III, until recently employed as assistant shop superintendent of Southeastern Liquid Fertilizer Co., Albany, Ga., is now in the employ of Brooks Chemical Co., Quitman, Ga.

•

Morton W. Bittinger has resigned as instructor in agricultural engineering at Iowa State College to join the engineering firm of Collins, Thompson and Willis, Marshalltown, Iowa. The firm is establishing a branch office at Algona, Iowa, where Mr. Bittinger will be located as resident engineer and will handle drainage and municipal work for surrounding counties and towns.

NECROLOGY

Thor W. Christensen, director of agricultural sales for Pacific Gas and Electric Co., passed away May 7, while visiting relatives at Sebastapol, Calif., at the age of 60.

Born at Santa Maria, Calif. in 1895, he grew up on California farms. In 1928 he joined the Pacific Gas and Electric Co., as a ground man in the electric department. That same year he was transferred to work as a rural service representative. During 12 years of service in this capacity he assisted in the design and development of electric farm equipment for special and general application. He made the most of opportunities to add to his education through courses of study made available by his company, and showed exceptional originality in dealing with problems encountered in his work. With this background he was transferred to the sales department and to the position held at the time of his passing.

Elected to membership in ASAE in 1945, he became an active worker in the Pacific Coast Section. He was elected to its executive committee in 1949, vice-chairman in 1950, and chairman in 1951. He had a broad understanding of the agricultural problems of central and northern California and a wide acquaintance among agricultural leaders in the area. Other organizations in which he was active included the California State Chamber of Commerce, San Francisco Chamber of Commerce, Western Farm Economics Association, and Pacific Coast Electrical Association.

He is survived by his widow, Lucie; a daughter, and a brother, Walter.

•

W. L. Beneditz, manager of rural development, Northern States Power Co., passed away April 25, at the age of 45.

A native of Juneau, Wis., he earned a bachelor of science degree in agriculture, majoring in agronomy and agricultural education, at the University of Wisconsin. After about 15 years of teaching vocational agriculture and experience as a county agent, he had been appointed in 1953 to the position held at the time of his passing.

NEW PRODUCTS CATALOGS

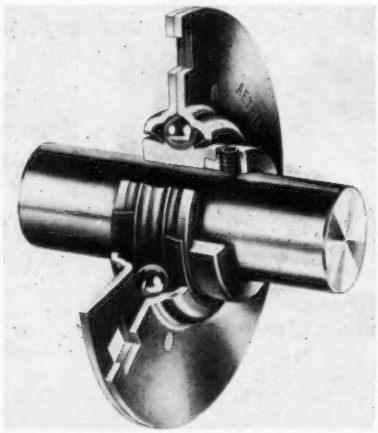
New Farm Steel Building

Armco Drainage & Metal Products, Inc., Middletown, Ohio, announces a new type of steel building, designed for large-volume grain storage and for general farm use, in the new 36-foot wide size as well as former widths of 20, 24, 28 and 40 feet. This building is reported to be the first of its type embodying interlocking steel panel

construction. No extra interior bracing is needed to withstand grain pressures. The interlocking panels and the minimum number of bolts facilitate erection, providing more usable space per square foot of floor area and assuring complete weather tightness. It is 36 x 48 x 8 feet high at the eaves and holds 12,800 bushels of shelled corn or wheat.

Adapter-Bearing Unit

Aetna Ball & Roller Bearing Co., a Division of Parkersburg-Aetna Corp., 4600 Schubert Ave., Chicago 39, Ill., has developed a new adapter bearing designed primarily for shafts supported by sheet metal members. It is a complete, single-package, prelubricated unit adapted to numerous applications where loads are light and speeds slow. The flange of the unit, which actually is the bearing outer race, can be bolted in place and the shaft slipped through and secured by an eccentric locking collar. This makes the unit adaptable to farm machinery and other uses where the maximum capacity requirements do not exceed 1,000 rpm and loads of 200 lb.



This unit is one of the company's new line of mounted ball bearings which include sprocket idler, belt idler, grain drill, and disk harrow and other farm implement units. One of their exclusive designed features is a flexible, self-contouring, one-piece seal of synthetic, grease-resistant rubber which provides positive contact under all conditions of misalignment.

Magnetic Liquid Level Gage

Rochester Manufacturing Co., Rochester, N. Y., announces a new magnetic liquid level gage, designed to be used in anhydrous ammonia or LP gas storage, mobile and applicator tanks.

The new gage features a new headplate design tested to withstand 1200 pounds per square inch of pressure and new shrouded

gear assembly which transmits float arm movement to the dial. Also featured in the new gage is the Rochester snap-on dial which permits field replacement of a damaged dial without removal of an entire gage which would call for emptying the tank of anhydrous ammonia.

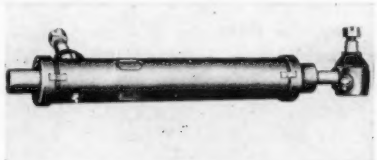
New Hydraulic Catalog

Aeroquip Corp., Jackson, Mich., will send on request its new 8-page farm catalog, Bulletin No. 141.

The new catalog contains up-to-date information and specifications on the company's complete farm line of breakaway and self-sealing couplings, hydraulic and grease hoses, and air, water, fuel and oil hose lines. In addition, a special section deals with farm kits that contain basic inventories of farm hose lines and fittings.

Hydraulic Steering Booster

Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich., announces that it can now supply a new low-cost oil-hydraulic power steering booster designed specifically for materials-handling vehicles in the 4,000 to 10,000-lb axle-loading class; combines, trac-



tors and other farm machinery having power ratings of 40 hp and up. The new unit, designated Vickers Series S22 Booster, achieves low cost with a simplified, streamlined double-tube construction. With the new design, the assembly tie rods are eliminated and replaced with end caps which are screwed on and secured with removable tack-welded clips.

CATERPILLAR LAND FORMING...
for Better Field Shapes

In the past, contour farming, with its inevitable point rows or small patches of untilled crop ground, has often been wasteful in terms of man and machinery hours. Today, many Caterpillar owners are cooperating with their Soil Conservation fieldmen to improve terraces or borders, and increase the ease of seedbed preparation, cultivation and harvesting.

Their CAT* track-type Tractors pulling scrapers or land levelers are forming the fields for better water management and land use . . . building slight crowns to facilitate drainage without erosion . . . filling in low spots so contour lines can be straightened and lengthened.

Land forming with Caterpillar equipment prevents natural or irrigation water from standing in low spots, where it may kill or slow down crops; or from quickly running off high places, causing rapid erosion.

In many areas, Caterpillar Dealers cooperating with Soil Conservation men have set up demonstration sites to prove the value of land forming. Results already obtained show marked increase in yields, and substantially lower operating costs.

This is but one of many ways Caterpillar Dealers and Caterpillar products are making better agriculture possible.
Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

Shown here is a Caterpillar D8 Tractor and No. 80 Scraper forming land near Palo Verde, California. Outfit is owned by J. E. Fulkerson of Blythe, California, who reports, "I have changed from other makes to Caterpillar because I get better service from my dealer and better performance from Caterpillar equipment."

CATERPILLAR*

*Both Cat and Caterpillar are registered trademarks — ®

CAT PRODUCTS HAVE MOVED MORE EARTH & CLEARED MORE LAND THAN ANY OTHER MAN-MADE POWER

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Acton, Russel D.—Farming and research, 1219 Robinson St., Danville, Ill.

Aiken, Charles R.—Educational director, Iowa Rural Electric Co-op Assn., Des Moines, Iowa. (Mail) 1141 58th St.

Albritton, James E.—Draftsman, National Fireworks Ordnance Corp. (Mail) RR 3, Box 161, Camden, Ark.

Annable, William P.—Agricultural engineer (SCS), USDA. (Mail) Barretts Hill Rd., Hudson, N. H.

Bardos, John J.—Engineering draftsman, International Harvester Tractor Works, Chicago 47, Ill. (Mail) 2538 Fullerton Ave.

Blair, David T. — Laboratory project engineer, Vickers, Inc. (Mail) 20710 Superior Rd., Wyandotte, Mich.

Borchelt, Martin C.—Student in agricultural engineering, North Dakota Agricultural College. (Mail) New Salem, N. D.

Bowers, Wendell — Extension agricultural engineer, University of Illinois, Urbana, Ill.

Branch, Rae W.—Chicago branch manager, Whitney Chain Co. (Mail) Hawthorn Woods, RR 1, Box 150-Al Lake Zurich, Ill.

Britt, Douglass K.—Territorial salesman of farm machinery, John Deere Plow Co. (Mail) RR 1, McCormick, S. C.

Brogger, James J.—Student in agricultural engineering, North Dakota Agricultural College. (Mail) Emerado, N. D.

Bunn, Joe M.—Student in agricultural engineering, University of North Carolina. (Mail) RR 2, Pikeville, N. C.

Clevenger, Hayden L. — Sales engineer, Food Machinery & Chemical Corp., Lakeland, Fla. (Mail) PO Box 1718

Cotcamp, Hugh D.—Student in agricultural engineering, Cornell University, Ithaca, N. Y. (Mail) 118 E. Falls St.

Curry, Lloyd W. — Agricultural engineer (SCS), USDA, Baker, Ore.

Daughtrey, Charles H.—Electrification adviser, Colquitt County Rural Electric Co., Moultrie, Ga.

Davis, Don G.—Ohio district manager, Basic Dolomite, Agricultural Div. of Basic Refractories, Inc., PO Box 576, Hudson, Ohio

Decker, Robert W. — Graduate research assistant in agricultural engineering, Pennsylvania State University, University Park, Pa.

Der Hovanesian, Joseph—Graduate teaching assistant in agricultural engineering, Michigan State College, East Lansing, Mich.

Diez, Angel M.—General manager, Miguelnos, S. A., Madrid, Spain. (Mail) Gaztambide, 47

Domier, Kenneth W.—Petroleum technician, Federated Co-operatives, Regina, Sask., Canada

Dunbar, Clarence W. — Chief engineer, Michigan Chemical Corp., Bankson St., St. Louis, Mich.

Fillbach, Myron A.—Power use adviser, FEM Electric Assn., Inc. Ipswich, S. D.

Freer, Vincent—Student in agricultural engineering, North Dakota Agricultural College. (Mail) Box 341, Dickinson, N. D.

Gantt, Charles W. Jr.—Assistant agricultural engineer, Agricultural Engineering Research Branch (ARS), USDA. (Mail) 42-J Ridge Rd., Greenbelt, Md.

Gascoyne, Paul R.—Farm representative, New Jersey Power & Light Co., 346 S. Main St., Phillipsberg, N. J.

Grein, Henry E. Jr.—Chief draftsman, Alloy Engineering and Casting Co. (Mail) 706 W. Vermont Ave., Urbana, Ill.

Hauck, Eugene C.—District representative, Diamond Chain Co., Inc., 215 6th St. S.E., Minneapolis 14, Minn.

Heckathorn, Loyd E.—Chief engineer and service manager, Towner Mfg. Co. (Mail) 13242 Newhope Rd., Garden Grove, Calif.

Heming, Thomas W.—Regional sales representative, Tractor & Implement Div., Ford Motor Co. (Mail) 1114 S. Grant St., San Mateo, Calif.

Huffaker, Ethan M.—Student in agricultural engineering, University of Idaho, Moscow, Ida.

Jackson, Rogers P.—Sales representative, Rome Plow Co., PO Box 853, Cedartown, Ga.

Johnson, James D.—Agricultural engineer (SCS), USDA. (Mail) RR 4, Box 152, Terrell, Tex.

Kirchhoff, Bernard A.—Sales representative, The Garlock Packing Co. (Mail) 2436 28th St., Moline, Ill.

Koumbarakis, George C.—Technical adviser Agricultural Bank of Greece, Athens 8, Greece. (Mail) 42 Lesvou St.

Long, William F. — Drainage engineer (SCS), USDA, Lincoln 10, Nebr. (Mail) 4810 A St.

McLaren, Glen D.—Blockman, Allis-Chalmers Mfg. Co. (Mail) Box 846, Dumas, Tex.

Manfrinato, Helio A.—Assistant professor of agriculture, Escola Superior de Agricultura "Luiz de Queiroz," Piracicaba, Est. de Sao Paulo, Brazil, S. A.

Mayer, Henry K.—Farm representative, New Jersey Power & Light Co., 18 Mine St., Flemington, N. J.

Morcillo, Luis E.—Head, agronomy dept., Escuela Agricola Panamericana. (Mail) 321-A Hickory Lane, East Lansing, Mich.

Nelson, Howard C.—Agricultural engineer (SCS), USDA, Stuart, Fla. (Mail) RR 1, Box 109

O'Brien, Jeremiah D.—Field engineer, J. H. Baxter & Co. (Mail) Bolinas Rd., Fairfax, Calif.

Packard, Gerald A.—Education manager, Columbia Tractor & Implement Co. (Mail) 2855 S. W. Upper Dr., Oswego, Ore.

Paustian, D. A.—Product education manager, Massey-Harris-Ferguson, Inc., 2850 Fairfax, Kansas City, Kans.

Pavik, Junior A.—Student in agricultural engineering, Iowa State College. (Mail) Britt, Iowa

Rabe, Frederick W.—F. W. Rabe & Co., PO Box 2727, Dallas 21, Tex.

Reed, James S.—Engineer inspector, University of Missouri, Columbia, Mo. (Mail) 112 Clinton Dr.

Reichard, Donald L.—Student in agricultural engineering, Pennsylvania State University. (Mail) RD 2, Bloomsburg, Pa.

Reiser, Kinney S.—Public relations-power use adviser, Northwest Iowa Power Cooperative, PO Box 1011, LeMars, Iowa

Rupp, Fred L. — Product sales manager, Granite City Steel Co., 20th and Madison, Granite City, Ill.

Schafer, Kenneth L. — Student trainee, Caterpillar Tractor Co. (Mail) RR 5, Wayzata, Minn.

Schmidt, Andrew H.—Engineer specialist (SCS), USDA, Grants Pass, Ore. (Mail) 1088 Portola Dr.

Senior, John L. Jr.—Owner and manager, Cluneboniff Farms, 22 Dan's Highway, New Canaan, Conn.

Smathers, James F.—Student trainee (SCS), USDA. (Mail) Box 195, Knapp Hall, Texas Technological College, Lubbock, Tex.

Speller, Eugene T. — Engineering trainee, John Deere Tractor Works, Waterloo, Iowa. (Mail) Y.M.C.A., 154 W. 4th St.

Stroup, Norman G.—Layout draftsman, International Harvester Co., East Moline, Ill. (Mail) 229 16th Ave.

Tarum, Clarence T.—904 4th Ave. N., Glasgow, Mont.

Tate, James R. — Agricultural engineer, Thermoid Co., Trenton, N. J. (Mail) 21 Sanhican Dr.

Upham, Joseph E.—Ranch foreman, Upham Ranch. (Mail) Box 224A Stare Route, Rio Vista, Calif.

Van Gerpen, Harlan W.—Junior engineer, John Deere Waterloo Tractor Works, Waterloo, Iowa

Viar, George W. — Agricultural engineer (SCS), USDA, Columbia, Tenn. (Mail) PO Box 132

Watson, Jerome A.—Student in agricultural engineering, North Dakota Agricultural College. (Mail) 604 S. Johnson, Charles City, Iowa

Willhelm, Joseph A. — Engineer trainee, Caterpillar Tractor Co. (Mail) 126 Maple, Morton, Ill.

Williams, Jack C. — Engineer, Structural Clay Products Institute. (Mail) 1025 L Ave., Nevada, Iowa

Wilson, William C.—Head, agricultural engineering dept., Compania Shell de Venezuela, Apartado 809, Caracas, Venezuela, S. A.

Woodward, Marshall—Acting agency land operations officer, Mescalero Indian Agency Mescalero, N. M.

Zachariah, Gerald L.—Student in agricultural engineering, Kansas State College, Manhattan, Kans. (Mail) 319 N. 15th

Zuch, Howard W.—Agricultural engineer, Texas A. & M. Extension Service, College Station, Tex. (Mail) 401 S. Dexter St.

Transfer of Membership Grade

Hicks, Jesse L. — Agricultural engineer (SCS), USDA, 221 Federal Office Bldg., Nashville, Tenn. (Associate Member to Member)

Hodges, T. O.—Associate professor of agricultural engineering, University of Missouri, Columbia, Mo. (Associate Member to Member)

Husa, V. Lennie — Agricultural engineer (SCS), USDA, Puyallup, Wash. (Mail) 424 7th Ave. N. E. (Associate Member to Member)

Stoneburner, Paul W. — General manager, Atlantic Aluminum Co., Inc. (Mail) RR 1, Box 355, Stuarts Draft, Va. (Associate Member to Member)

It's loaded with...
ADVANCED ENGINEERING FEATURES!

NEW IDEA

the only MOUNTED PICKER with detachable, trailing, 10-roll husking bed!

EXCLUSIVE trailing husking bed—biggest in NEW IDEA history—takes weight off tractor. Quickly detached, frees tractor for other jobs.

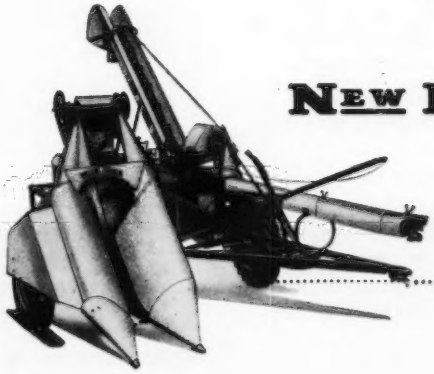
Designed for faster picking and heavier yields . . . **and clean corn** . . . check some of the outstanding features of the NEW IDEA Mounted Picker:

- fits 19 different tractor makes and models
- when farmers trade in their tractors, it isn't necessary to trade their NEW IDEA Mounted, too—chances are a set of inexpensive mounting brackets will fit it to the new tractor.
- distribution of weight on 6 wheels takes burden off tractor . . . one-third of the weight is on caster wheels . . . makes work possible in softer fields where other pickers cannot operate.
- extra large husking bed for extra clean corn. 10 extra long husking rolls with 10 presser wheels and two ear straighteners give biggest capacity in NEW IDEA history. Made possible by *exclusive* trailing husking bed.
- picks 36" to 44" rows.
- triple gathering chains and floating points get tangled and down corn.
- turns sharp—wagon turns in the same radius as the tractor.

- controls near tractor seat for (1) wagon elevator clutch, (2) ear deflector, (3) clearance between snapping rolls, (4) raising and lowering snapping unit.
- 21 ball and roller bearings, 9 safety ratchets.

Throughout last year's corn harvest NEW IDEA engineers checked hundreds of NEW IDEA Mounted Pickers in every kind of corn and field condition. They learned how to improve the performance of this outstanding picker, and to add to its expected long life.

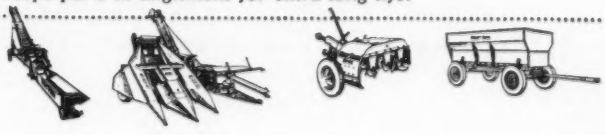
These improvements are being built into this year's production of the "new idea" in mounted pickers that is *years ahead* of conventional mounted pickers.



NEW IDEA FARM EQUIPMENT CORP.
COLDWATER, OHIO, U. S. A.
DIVISION AVCO DISTRIBUTING COMPANY

NEW IDEA FARM EQUIPMENT

NEW IDEA'S 1-row pull type picker (the well-known No. 7) has won more state and national corn picking contests than any other picker. Rigid box frame keeps parts in alignment for extra long life.



Oil Power Helps Manpower
Guide Horsepower with
EASE!

Arm-weary tractor operators are grateful for TD-14A and TD-18A International Harvester crawlers. They steer with the ease of a late model car for each track is controlled by its own hydraulic circuit...a booster system with velvet smooth, positive action that stems from

HYDRECO
Oil Power

Here is a HYDRECO dual pump that delivers 5 gpm to each circuit at 1200 rpm against a system pressure of 700 psi. The dual pump provides a circuit for each track and the result . . . no arm-weary operators . . . more accomplished with less effort, in less time . . . smoother, higher performance . . . lower maintenance.

For engineers seeking practical answers to problems of trouble-free hydraulic controls, better performance, added functions and greater sales appeal for mobile equipment, the experience of HYDRECO engineers offers a definite answer!

WRITE— *for latest literature and full information on new developments in HYDRECO Pumps, Motors, Valves, and Cylinders.*

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1107 EAST 222nd STREET • CLEVELAND 17 • OHIO
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

NEW BOOKS

Engineering in Agriculture, by P. H. Southwell. Cloth, XII + 260 pages, 5½ x 8½ inches. Illustrated and indexed. Temple Press, Ltd., Bowling Green Lane, London, E C 1, in association with *Farm Mechanization.* 30 S

A British text for students of agriculture and agricultural engineering, and a reference for farmers, this work relates principles of the basic branches of engineering to their agricultural applications. Chapters cover introduction and subject survey, basic data, heat and combustion, work, energy, power and motion, friction forces, machines and mechanisms, heat engines and pumps, stress and structures, hydraulics, pneumatics, electricity, efficiencies, strength, properties and use of materials, earthworks and surveying, drawing and design. Appendixes provide ready reference to basic data, useful general data, and trogonometric tables.

Chemistry of the Soil, edited by Firman E. Bear. Cloth, x + 373 pages, 6 x 9 inches. Illustrated and indexed. Reinhold Publishing Corp., 420 Park Ave., New York 22, N.Y. $8.75. This is published as No. 126 in the American Chemical Society's series of chemical monographs. The introduction is written by Firman E. Bear. Chapters and their authors are soil development by Isaac Barshad; chemical composition of soils by Kirk Lawton; colloid chemistry of soils by Stephen J. Toth; cation and anion exchange phenomena, by Lambert Wiklander; soil organic matter by George K. Fraser; soil fixation of plant nutrients by Louis T. Kardos; oxidation-reduction processes in soils by F. G. Merkle; acid, alkaline, alkali and saline soils by D. Wynne Thorne and Lloyd F. Seatz; trace elements by Robert L. Mitchell, and soil chemistry and plant nutrition by Adolph Mehlich and Mack Drake. Arthur L. Prince is author of an appendix on methods in soil analysis.

Moving the Earth, by Herbert L. Nichols, Jr. Fabricoid, 1280 pages, 6½ x 9½ inches. Illustrated and indexed. North Castle Books, 212 Bedford Rd., Greenwich, Conn. $15.00.

Subtitled "The Work Book of Excavation," this is an extensive treatment of the subject of reference value to contractors, public works officials and private individuals concerned with planning, supervising or practicing excavation or other earthmoving jobs beyond the scale of hand shovel jobs. Chapters in Part 1, *The Work,* cover land clearing, levels and locations, soil and mud, stuck machinery, cellars, ditching and dewatering, ponds, landscaping and agricultural grading, roads, rock blasting and tunneling, pit operation, and making and losing money. Part 2, *The Machines,* has chapters on basic information, revolving shovels, conveyor machinery, tractors and bulldozers, tractor loaders, scrapers, dump trucks and wagons, grading and compacting machinery, compressors and drills, and miscellaneous machinery.

The Gyroscope Applied, by K. I. T. Richardson. Cloth, 384 pages, 6 x 9 inches. Illustrated and indexed. The Philosophical Library, Inc. (15 E. 40th St., New York 16, N. Y.) $15.00.

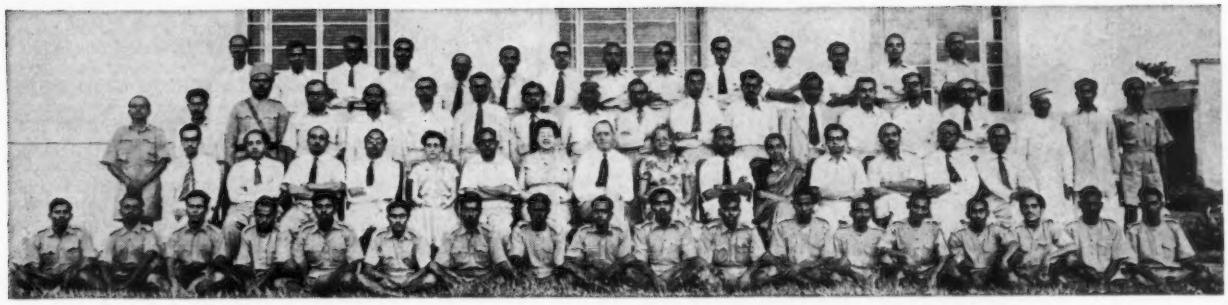
Here is good reading, as well as an important reference, for the engineer who may be intrigued by the mechanics, applications and additional possibilities of the gyroscope, as well as for those who may encounter work assignments in this field.

(Continued on page 492)

BURLAP BULLETIN

News about packaging and agricultural and industrial developments in burlap

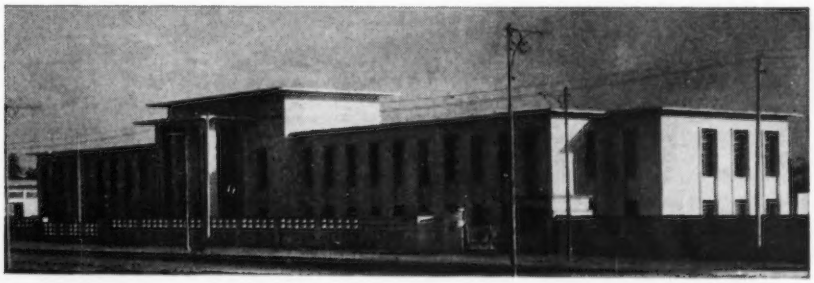
ANY PROBLEMS FOR THESE RESEARCHERS?



The Indian Jute Mills Association Research Institute (IJMARI) of Calcutta, India. Over 80 scientists, technologists and other workers devote their entire attention to the testing and development of jute and jute fabrics in six separate but related groups. These are Background Research, Applied Research, Development Research, Technical Service, Standardization, and Information Service. Among the many valuable contributions made by the Research Institute to the cause of improving jute products and their utility as packaging and industrial fabrics, are the development of a rot-proofing process and a method of bleaching and softening burlap; as well as the use of an asphalt-impregnated jute fabric in war-time construction projects which demonstrated a principle which may soon be successfully applied to important agricultural uses. The work of this staff has directly benefited American agriculture and industry through the advances in the quality and performance of burlap, and the adaptation of the fibre to new uses where it has effected a saving of time or money.

DR. W. H. MacMILLAN, Ph.D., B.Sc.— Research Director of the Institute who first came to Calcutta in 1937 as chief chemist of the Indian Jute Mills Association. He is the author of over 50 scientific and technical papers and plays an important part in the scientific and textile societies

of India. He is Chairman of the Calcutta section of the Textile Institute of Great Britain and Northern Ireland. His assistance is available for the solution of any problems submitted on behalf of American agricultural and industrial engineers.



This modern, completely air conditioned building which houses the IJMARI staff was opened on January 2, 1952 by Prime Minister Nehru. It contains a lecture room, vast libraries, a display room, and 17 laboratories. It is typical of the "new" India in which jute plays an important role as the country's largest dollar earner and figures prominently in the country's determination to meet and exceed the high standards set by the American market.

How to put the IJMARI staff to work on your problems

Burlap — agriculture and industry's toughest and most versatile fabric—is playing new and varied roles all over the world today. Take advantage of the complete research facilities at IJMARI for any projects you are working on. You can easily arrange this through Wm. A. Nugent, Vice President, The Burlap Council, 155 E. 44th St., N. Y. 17.

Published by The Burlap Council of the Indian Jute Mills Association
155 East 44th Street, New York 17, N. Y.

NEW BOOKS

(Continued from page 490)

How to Build Nailed Trussed Rafters, by E. George Stern. Practical Building (5 S. Wabash Ave., Chicago 3, Ill.) 50 cents per copy. This is a 27 page bulletin in 8½ x 11-inch page size, presenting economies of nailed trussed rafters. Dimensioned diagrams illustrate the construction described, down to nail positions in some cases.

Soil Fertility, by C. E. Millar. Cloth, xi +436 pages, 6 x 9 inches. Illustrated and indexed. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $6.75.

This work presents the subject with special emphasis on interrelationships between soils and growing plants. Chapters cover the development of agriculture, essentials for plant growth, the soil solution and nutrient absorption by plants, colloids and soil productivity, soil reaction and liming, soil organic matter, nitrogen and crop production, phosphorous, potassium, calcium and magnesium, sulfur, micro and some non-essential nutrients, soil deficiencies and determination of nutrient needs of crops, activities of soil organisms that affect productivity, green manures, crop residues, and composts, animal manures, contributions of commercial fertilizers to soil productivity, rotations and farming systems, and a summary of old field experiments.

Approved Practices in Soil Conservation, by A. B. Foster. Paper, spiral binding, 380 pages, 5 x 8½ inches. Illustrated and indexed. Interstate Printers and Publishers, Danville, Illinois. $2.40. This is an operating guide to step-by-step procedures in planning, laying out, and applying many of the well-known soil conservation practices. Chapters cover Using Land Within Its Capabilities, Rotating Crops, Engineering Instruments, Calculating Runoff From a Watershed, Grassed Waterways and Outlets, Farming on the Contour, Contour Fences, Strip Crop Farming, Laying Out and Constructing Terraces & Diversions, Laying Out and Constructing Ponds, Sandblows, Planting Shelterbelts, Managing Farm Woodlands, Managing Land for Wildlife, Improving and Managing Pastures and Ranges, Laying Out and Constructing Farm Drainage, and Conservation Irrigation.

ASTM Standards on Petroleum Products & Lubricants. Cloth, 956 pages, 6 x 9 inches. Illustrated and indexed. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $6.65

This is an annual compilation brought up to date to November 1954, combining ASTM Standards on Measuring and Sampling Petroleum and Petroleum Products, Crude Petroleum, Liquified Petroleum Gases and Natural Gases, Butadiene, Motor and Aviation Fuels, Engine Test Methods for Rating Fuels, Petroleum Solvents and Naphthas, Industrial Aromatic Hydrocarbons, Diesel Fuels, Distillate Burner Fuels, Kerosene and Illuminating Oils; Lubricating Oils, Electrical Insulating Oils, Lubricating Greases, Petroleums and Paraffin Waxes, Bituminous Materials, and miscellaneous matters. Several additional proposed standards are presented in appendices.

Farm Mechanization Directory, 1955. (Fifth Edition). Paper, vi+544 pages, 5½ x 8½ inches. Illustrated and indexed. Temple Press, Ltd., Bowling Green Lane, London, E. C. 1. 21 shillings net. Parts and sections are as follows: Part I, Organizations interested in farm mechanization, manufacturers' names and addresses, trade marks, names and abbreviations. Part II, Tractor specifications and manufacturers, index, agricultural tracklayers, wheeled tractors—over 10 hp; wheeled tractors up to 10 hp; walking type tractors and motor hoes; industrial and forestry tracklayers and wheeled tractors. Part III, Tractor technical data, index, British Standard Specifications. Part IV, Test reports, tractors, implements, dairy machinery. Part V. Implements, classified section, and approved implements. Part VII. Index to implement classification, index to advertisers.

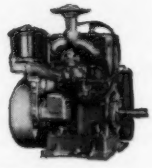
Illustrated here are a few of the many farm equipment and service applications on which Wisconsin Engines are extensively used.

Wisconsin Heavy-Duty Air-Cooled Engines offer farm power equipment users the cumulative benefits of many years of exclusive specialization in the design and manufacture of air-cooled engines, in a complete power range from 3 to 36 hp. Here is rugged, dependable power to fit both the *job* and the *machine*, adapted to the widest farm and orchard service applications.

Heavy-Duty Design and Construction gives Wisconsin Engines the in-built stamina that is assurance of "Most H.P. Hours" of on-the-job service, long engine life and low-cost maintenance. Tapered roller bearings at BOTH ends of the crankshaft take up side-thrust and end-play, providing maximum protection against bearing failure as well as smooth running. An easily accessible rotary type high tension OUTSIDE Magneto, equipped with Impulse Coupling for easy starts in any weather at low cranking speeds, provides positive ignition. Pump circulated splash lubrication on smaller models and geared oil pump delivering individual oil stream to each rod on multi-cylinder models, plus exceptionally efficient AIR-COOLING at temperatures up to 140°F. are additional features that contribute to dependable power performance, long engine life and low-cost maintenance. Every Wisconsin Engine is noted for Lugging Power that *hangs on* and keeps the job moving through the shock-load pinches.

These are a few of the reasons why more farm and orchard machines are powered by Wisconsin Heavy-Duty Air-Cooled Engines than any other make. Write for copy of 64-page Wisconsin Engine Blue Book. Form S-150.

4-cycle single cyl. models 3 to 9 hp.


2-cylinder models 7 to 15 hp.

V-type 4-cylinder 15 to 36 hp.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

A 8282-1PA

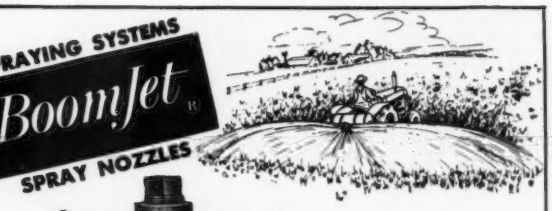
USDA RESEARCH NOTES

Fruit Handling Tests Extended. Success of the orchard-to-processing-plant handling of cherries by water tank truck, as devised and developed by Engineers Levin and Gaston, had led to tentative plans for the water handling of peaches this season, as well as to further expansion in the experimental handling of cherries. The experimental work on cherries will be aided materially by acquisition of 6 water tanks of 3 tons capacity each.

Split-Level House. An article on the Farm Buildings Section's experimental split level house (Plan 7128) at Agricultural Research Center, Beltsville, Md., that appeared in the April issue of *Popular Science,* has created what promises to be a record run of requests for plans. Some 600 requests from nearly every quarter of the nation have been received by the Farm Buildings Section, USDA, at Plant Industry Station, Beltsville, and an undetermined number have been received through extension agricultural engineers at many state agricultural colleges.

Since USDA does not distribute plans for farm houses or buildings, requests for these plans should be addressed to extension agricultural engineers at state agricultural colleges.

SPRAYING SYSTEMS
BoomJet®
SPRAY NOZZLES



Patent No. 2,619,388

up to 66 feet WIDE with one compact assembly

for the broadcast spraying of grains, grasses and liquid fertilizers

Easily mounted on rear of tractor. Use where spray boom accuracy is not needed. Sprays to both sides in field spraying or one side only in fence row or road side spraying. A Spraying Systems Co. **original design.** Made in all brass for general farm spraying and in all aluminum for spraying liquid fertilizers. For complete information write for Bulletin 66.

GunJet SPRAY GUNS
All capacities. Write for Bulletins 65 and 69

For TeeJet SPRAY NOZZLES . . . write for Bulletin 58

SPRAYING SYSTEMS CO. 3226 Randolph Street Bellwood • Illinois

336,000
miles of extrusions!

Our extruders have turned out enough plastic and rubber extrusions to reach to the moon and halfway back. In compiling this vast experience General Tire's Industrial Products Division has supplied thousands of original equipment manufacturers with just about every known type of extrusion. No job is too large, too small or too complicated for our design and production staff. Perhaps *you* can benefit from the fantastic extrusion mileage we've accumulated down through the years.

For literature or further information write to The General Tire & Rubber Company, Wabash, Indiana, Department F.

"From Plans to Products in Plastics and Rubber"

THE GENERAL TIRE
Industrial Products Division
WABASH INDIANA

Who Should Join ASAE

If any one of the following descriptions covers your present work:

- Development, design, and application of farm tractors and implements and their components
- Design and improvement of farm buildings
- Engineered improvements for soil and water conservation and use
- Creating applications for elctricity in farm practice and living—

then you can derive much benefit from membership in ASAE, and the Society cordially invites you to make application. For further information write

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
St. Joseph, Michigan

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—JANUARY—O-437-667, 438-668, 447-672. FEBRUARY—O-19-704, 32-705, 33-706, 18-709. MARCH—O-55-710, 61-713, 71-714, 87-715. APRIL—O-120-716, 125-718, 155-719, 143-720, 173-721. MAY—O-200-722, 197-723, 180-724, 196-725, 205-726, 214-727, 214-728. JUNE—O-235-730, 244-731, 268-732, 248-733.

POSITIONS WANTED — DECEMBER — W-411-166. 1955—MARCH—W-17-2, 27-6. APRIL—W-114-8, 4-10, 133-11, 67-14. MAY—W-154-15, 165-16, 177-17, 176-19, 206-21, 182-22, 213-23. JUNE—W-179-24, 203-25, 247-27, 250-28, 252-29, 245-30, 263-31, 208-32.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER for extension work as farm advisor in Los Angeles County, Calif. Age 25-36. BS deg in agricultural engineering, or equivalent, from accredited curriculum. Farm background or recent agricultural engineering work experience. Ability to cooperate and work with subject matter specialists in various fields. Opportunity for advancement in regular steps. Auto and travel expense within county furnished. Opportunity for travel in state and for further education. Salary open, depends on experience and educational background. O-267-734

AGRICULTURAL ENGINEERS (2 in each of project, design, and junior grades) for design and development of hydraulic devices and actuating circuits for use on agricultural equipment, with leading manufacturer of broad line of components. Midwest location. BS deg in engineering, or equivalent in experience. Experience with operation and design of hydraulic equipment desirable. Also general knowledge of control requirements of agricultural implements. Neat appearance. Ability to think on feet. Personality to permit customer contact. Excellent opportunity in progressive organization with executive personnel drawn largely from engineering staff. Salary open. O-289-735

AGRICULTURAL ENGINEER (assistant professor and assistant agricultural engineer rank) for teaching and research in farm power and machinery and farm mechanics in land grant college and experiment station of a northern plains state. Age 25-40. MS deg in agricultural engineering or man with BS deg who is willing to work for MS deg. Several years teaching, research or extension experience. Recent graduate considered at instructor rank. Good personality and interest in research and teaching. Good opportunity for advancement. New agricultural engineering building with excellent equipment for teaching and research. Salary open. O-297-736

AGRICULTURAL ENGINEER (graduate research assistant) for study and development of new forage handling methods and equipment, with special emphasis on handling baled hay, in land grant university of a northeastern state. BS deg in agricultural engineering or equivalent. Usual qualifications for advanced study and public service research. Excellent opportunity for advancement in expanding research program. Should be abje to complete requirements for MS deg in 3 semesters. Salary $2000 per year, plus tuition. O-298-737

AGRICULTURAL ENGINEER (assistant professor rank) to teach academic courses at senior college level, in farm shop, farm machinery, motors, electrification and farm machinery sales and operation. Eastern location. MS deg in agricultural engineering with specialization in farm machinery or BS deg in agriculture with major in agricultural engineering or agricultural machinery. Must have extensive experience in all practical phases of tractor and farm machinery operation and ability to instruct. Opportunity for advancement toward head of department. Opening effective September 6. Salary open. O-303-738

AGRICULTURAL ENGINEER (assistant rank) for work as farm building plan service specialist. Eastern location. BS deg in agricultural engineering, with major interest in farm buildings. Usual training in drafting. Neat, agreeable, cooperative and able to meet public. Opening effective September 1. Salary $3888-4752. O-307-739

ENGINEER for design work with nationally known manufacturer of industrial seating. Prefer man with seating experience. Give full details in first letter. Salary open. O-316-740

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for extension, teaching, research, or writing, in public service or with consultant, anywhere in USA, possibly some other countries. Married. Age 35. No disability. BS and MS degs in agriculture, Cornell University, 1942 and 1953. Full time extension in agricultural engineering, district agricultural engineer, since February 1944. Acting agricultural engineering extension specialist since August 1954. War commissioned service in Army, 1½ yr. Available September 1. Salary open. W-225-34

AGRICULTURAL ENGINEER for design, development, or research in power and machinery with experiment station, manufacturer or farming operation, anywhere in USA. Married. Age 31. No disability. Graduate of agricultural college in Czechoslovakia in 1944. Diploma in agricultural engineering, Engineering University, Prague, 1948. Experience State Institute for Research and Testing of Agricultural Machinery, Prague; State model farm, Denmark, 1947; vice-manager at Station de Motoculture, Madagascar, 1949-52; testing and research engineer, French Department of Agriculture, 1953; technical manager of two French companies 1953-54. Recent immigrant to USA. Currently engineer-machinist on production and maintenance work outside of agricultural engineering field. Available on reasonable notice. W-266-35

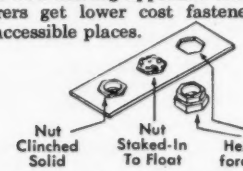
AGRICULTURAL ENGINEER for design, development and research in power and machinery field, with manufacturer anywhere in USA. Married. Age 23. No disability. BS deg in agricultural engineering, 1953. Pennsylvania State University. Farm background. Farm manager one year. Part-time electrician. Post-war Armed Forces Service 1953 to present, enlisted. Duty as a supervisor on farm of an Army rehabilitation center. Available September 25. Salary open. W-295-36

AGRICULTURAL ENGINEER for design, development or research in power and machinery with industry, anywhere in USA. Married. Age 27. No disability. BS deg in agricultural engineering, 1952, Iowa State College. Farm background. Engineering design 3 yr, including 18 mo training program, and 18 mo as product designer on layout and design of tractor components. Enlisted service 2 yr, Army Signal Corps. Available September 16. Salary open. W-265-37

use these
GRIPCO CLINCH NUTS
with the exclusive
hex on hex
feature

for "fixed" fastenings for "hard-to-reach" or blind assemblies. They wear longer, hold tighter, give greater customer satisfaction.

See how leading appliance manufacturers get lower cost fasteners into inaccessible places.



Gripco Clinch Nuts can be either clinched solid for a rigid application or staked in with a six point staking punch to give a floating effect. This floating effect takes care of misalignment and makes the application of the bolt easier. Gripco clinch nuts can be clinched or staked with stationary or portable hydraulic or air equipment. Details on request. Write for samples and data sheet.

Typical Applications

Automatic Washer for leg leveling and crating on all appliances

Tractor Seats

Power Lawn Mowers

Automobile Frames

GRIP NUT COMPANY
311-M S. Michigan Ave., Chicago 4, Illinois
113

the BADGE of him who BELONGS

DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

But the Society emblem is *evidence* that native talent, be it great or small, is enriched by fraternity with the personalities whose minds fuse to form the pattern of progress in the methods and mechanics of agriculture. The wearer of the emblem waits not for the debut of an idea, but is present at its birth and helps to guide its growth.

Be you novice or veteran, your membership in the organized profession adds something to your efficiency, your vision, your influence as an individual engineer. The Society symbol on your lapel is token that you "belong". Wear it.

STYLES AND PRICES OF ASAE EMBLEMS

With blue ground for Fellows, Members, and Associate Members — furnished either in pin with safety clasp or lapel button — $3.50 each.

With red ground for Affiliates — furnished only in pin with safety clasp — $3.50 each.

Send orders to ASAE, St. Joseph, Michigan.

THOMAS J. WATSON, JR. Portrait by Fabian Bachrach

"IBM was one of the first companies to . . ."

"I have always been proud of the fact that IBM was one of the first companies to put into effect the Payroll Savings Plan for the purchase of United States Savings Bonds, and I am delighted to see this patriotic endeavor continuing year by year and increasing throughout our organization. Today thousands of IBM employees, through their participation in the Plan, are helping their country and providing for the future of their families and themselves." **THOMAS J. WATSON, JR.,** ***President International Business Machines Corporation***

If employee participation in *your* Payroll Savings Plan is less than 50% . . . or, if *your* employees do not now have the opportunity to build for their future through the systematic purchase of U.S. Savings Bonds . . . a letter to: Savings Bonds Division, U.S. Treasury Department, Washington, D. C., will bring prompt assistance from your State Director. He will be glad to help you put on a person-to-person canvass that will put an application blank in the hands of every employee. This is all you have to do. Your men and women will do the rest, because they will welcome the opportunity to build for personal and national security.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

AGRICULTURAL ENGINEERING

Index to Advertisers

American Bosch Corp. 446
Armco Steel Corp. 447
Bearings Co. of America 485
Blood Brothers Machine Div., Rockwell Spring and Axle Co. ... 433
Burlap Council, Indian Jute Mills Assn. 491
J. I. Case Co. ..... 2nd cover
Caterpillar Tractor Co. 487
Chain Belt Co. 437
Chrysler Corp., Industrial Engine Div. 444
Deere & Company 451
Diamond Chain Co. 450
Electric Auto-Lite Co. 438
Ethyl Corp. 448
Fafnir Bearing Co. 445
General Tire & Rubber Co., Industrial Products Div. 493
Great Lakes Steel Corp., Stran-Steel Div. 442
Grip Nut Co. 494
Hydreco Div., The New York Air Brake Co. 490
Ingersoll Products Div., Borg-Warner Corp. 452
International Harvester Co. 483
Kaiser Aluminum & Chemical Sales, Inc. 440
Kohler Co. 494
Link-Belt Co. 449, 481
McDowell Mfg. Co. 496
Mechanics Universal Joint Div., Borg-Warner Corp. 436
New Departure, Div. of General Motors ..... 3rd cover
New Idea Farm Equipment Co. 489
The New York Air Brake Co. 490
Spraying Systems Co. 493
Stephens-Adamson Mfg. Co., Sealmaster Div. 441
The Timken Roller Bearing Co. 4th cover
The Torrington Co. 435
U.S. Steel Corp. 479
Wisconsin Motor Corp. 492

Professional Directory

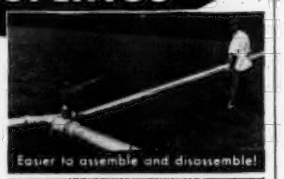
RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

FRANK J. ZINK
Agricultural Engineering Service
Development - Design - Research - Markets
Public Relations
BOARD OF TRADE BLDG., CHICAGO 4, ILL.
Tel. HArrison 7-0722

J. F. SCHAFFHAUSEN
Agricultural & Sales Engineering
Research Farms: United States - Canada
Market Development, Sales Training, Design, Public Relations, Editorial Services
IRVINGTON-ON-HUDSON, NEW YORK

COPIES AVAILABLE
AGRICULTURAL ENGINEERS YEARBOOK
Contents includes (1) ASAE-Approved Standards, Recommendations, and Engineering Data; (2) Directory of Suppliers to Agricultural Engineers; (3) Roster of ASAE Members; (4) List of ASAE Officers, Divisions, Sections, and Committees. Published by the American Society of Agricultural Engineers, this publication is an essential and frequently consulted reference source for every agricultural engineer, as well as for any individual, organization, or library in need of the particular information it contains.
Copies of the current edition of AGRICULTURAL ENGINEERS YEARBOOK are available at $5.00 per copy postpaid. Send order with remittance to
American Society of Agricultural Engineers
St. Joseph, Michigan

For **PORTABLE SPRINKLER IRRIGATION** that ***WORKS BETTER*** with ***LESS WORK***...



The ORIGINAL AUTOMATIC PRESSURE-LOCK DESIGN ...

In this patented construction, water pressure provides a tight seal and positive lock automatically—at both high and low pressures. No tools are needed—and there are no clamps, yokes or latches to bother with, break or wear out. The result: a McDowell Coupling portable irrigation system requires less work, less upkeep ... saves time and effort ... does a better job ... and costs less in the long run. Want proof? Ask your local McDowell dealer for a demonstration.

McDowell—The Best Coupling Made!
Made in sizes 2" through 8".

For Complete Details ... Free Booklet ...
MAIL COUPON TODAY!

4-G
Name_____
Address_____
City_____ Zone____ State_____
McDOWELL MANUFACTURING CO. Pittsburgh 9, Pa

A Handsome, Permanent Binder for AGRICULTURAL ENGINEERING

One copy **$2.80**
Two or more
$2.40 each

THE ONLY binder that opens flat as a bound book! Made of durable, green imitation leather, nicely stamped on backbone, with the name of journal and year and volume number, it will preserve your journals permanently. Each cover holds 12 issues (one volume). Do your own binding at home in a few minutes. Instructions easy to follow. Mail coupon for full information, or binder on 10-day free trial.

MAIL COUPON TODAY

THE SUCKERT LOOSE-LEAF COVER CO.
234 West Larned St., Detroit 26, Mich.

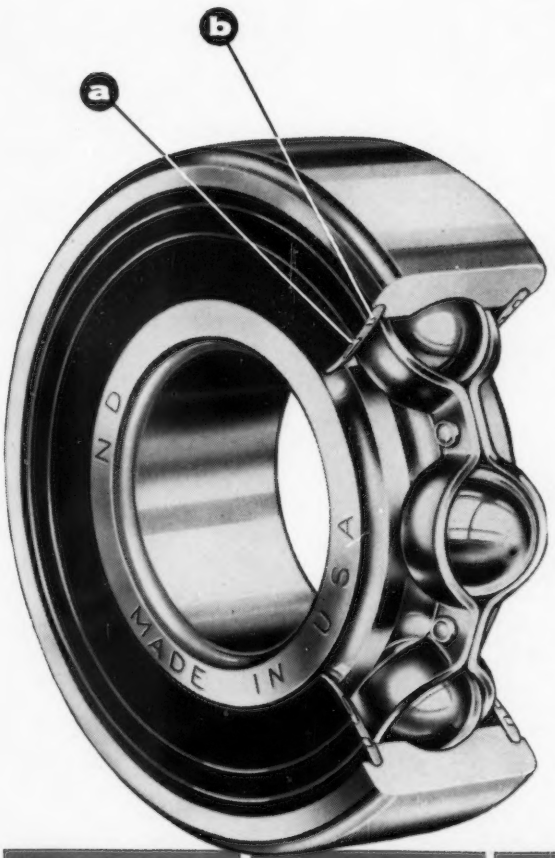
Mail postpaid_____ binders for Agricultural Engineering for years_____
Will remit in 10 days or return binders.

Name_____
Address_____
City_____ State_____

FACTS

about

NEW DEPARTURE
BALL BEARINGS



New Sentri-Seal...on guard against dirt and wear!

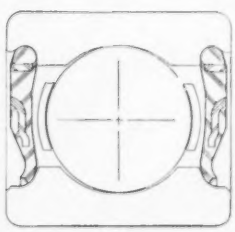
The unique design of the Sentri-Seal gives optimum protection against dirt, and includes a number of other major advantages.

Sentri-Seals are quickly removed, easily replaced. As the seal is of synthetic rubber, in which two metal rings are embedded, a constant-rate spring is created between the rings. Inherent flexibility prevents distortion of the bearing outer ring due to seal insertion, permitting the use of bearings to the higher accuracy specifications. The spring action maintains an efficient sealing contact with the bearing ring to bar dirt and retain lubricant. Sentri-Seals are relatively inert to oils and greases and operate satisfactorily through a temperature range of −40°F to 225°F. Specifications available for still higher temperatures. In applications where relubrication is desired, it is easily accomplished by the injection method.

The New Departure Sentri-Seal basically consists of two separate metal rings, "A" and "B", embedded in synthetic rubber, resulting in a spring which absorbs distortion and deflection. The seal is not drastically influenced by axial displacement due to bearing end-play within prescribed tolerances, and provides efficient sealing at low torque. Bearing shown is equipped with two seals.

The diagram shows in section the New Departure Sentri-Seal. Lip contacting surfaces are form-ground simultaneously with the ball race, giving an extremely high degree of concentricity between sealing surfaces and the raceway.

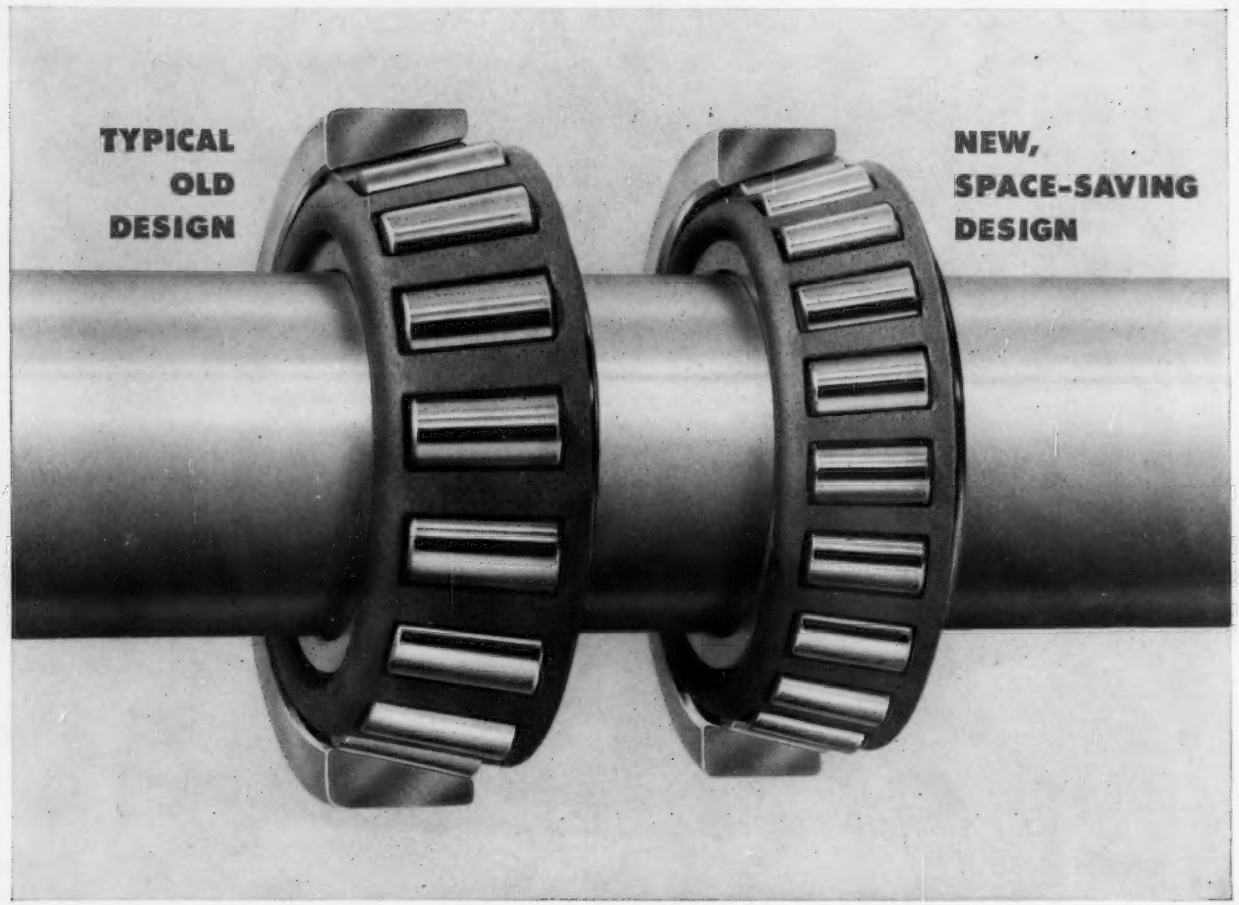
Sentri-Seal is available for a range of sizes in single-row, standard-width bearings and also in two types of New Departure adapter bearings. Sizes, dimensions and capacities are listed in the latest New Departure catalog.



Write for full details on Sentri-Seal

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

New capacity-packed TIMKEN® bearings save space and weight, cost less than previous bearings of same bore sizes



HERE'S big cost-saving news if you use bearings in ¾", 1¼" or 1⅜" bore sizes.

The Timken Company has designed three new tapered roller bearings that take up less space, weigh less than previous bearing designs and cost less! They're packed with capacity, too — no bearings have ever delivered so much capacity in so little space.

If you now use tapered roller bearings of these bore sizes you can enjoy big savings two ways by redesigning for the new Timken® bearings: savings in bearing cost and, because the bearings are smaller, savings in related parts.

The new Timken bearings also make it possible for you to enjoy the advantages of tapered roller bearings in many additional applications—and at minimum cost.

In less than a year, industry has already designed well over 1,000,000 of the new Timken bearings into its products. Why not re-examine your bearing applications today to see if you, too, can reduce the manufacturing cost of your products, or improve their performance, or both, by adopting the new low-cost Timken bearings. Bearings and all auxiliary parts are immediately available. Write: The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN ... your number 1 bearing **VALUE**

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬭ AND THRUST →⬭← LOADS OR ANY COMBINATION →✳←